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Contents

REVIEW ARTICLE

ALLELOPATHIC SUPRESSION OF SOME BROAD LEAVED WEEDS

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Abstract: Allelopathy is environmentally safe tool for removal of hazardous weeds which interferes with crops in terms of nutrition, space, fertilizers. The weed plants affect the growth of crop plants through secreting certain allelochemical subsances. To solve this problem, a majority of research has been done to evaluate the properties and effects of allelochemicals extracted from plants or procured. In this review effect of allelochemicals on some selected broad leaved weeds like black nightshade (*Solanum nigrum* L.), goatweed (*Ageratum conyzoides* L.), indian mallow (*Abutilon indicum* (Linn.) Sweet, velvetleaf (*Abutilon theophrasti* Medik.), coffee senna (*Cassia occidentalis* L.), sicklepod (*Cassia obtusifolia* L.) have been discussed for their management.

Key words: Allelopathy, Allelochemicals, Crop, Weeds

INTRODUCTION

In 1937, Austrian botanist, Hans Molisch, described this phenomenon as allelopathy, which he determined to be the result of biochemical interactions between plants (Molisch 1937; Putnam and Duke 1978). When first described, allelopathy referred to both deleterious and beneficial interactions between species; since that time, however, allelopathy has been applied to only adverse plant interactions, rather than to both. Allelopathy involves the synthesis of bioactive compounds capable of growth regulation, weed infestation control and pest management that resolve the problem of health defects and environmental pollution caused by ruthless use of synthetic chemicals (Dayan *et al*., 2009; Macías *et al*., 2007). These weeds compete with cultivated crops and retard their growth by releasing the growth inhibiting chemicals. Allelopathy is economical and ecofriendly solution to control such weed infestation and found in different parts of the plants with varying concentration and composition ,and their pathways to release these compounds into the environment are species dependent (Gatti *et al*., 2004).

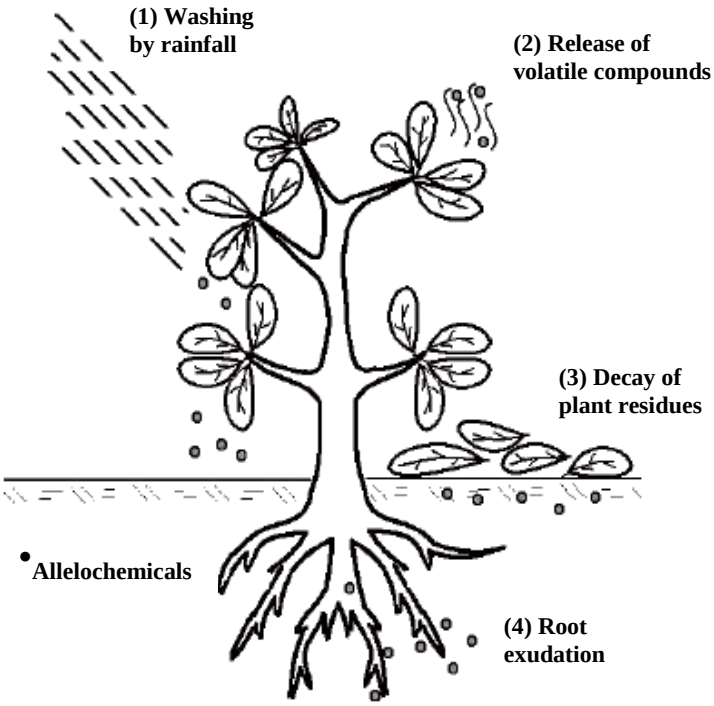

Figure 1: Pathways of releasing allelochemicals from different plant parts

Allelopathins are products of the secondary metabolism and are non-nutritional primary Metabolites (Weir *et al*., 2004; Iqbal and Fry, 2012). These compounds belong to numerous chemical groups including: triketones, terpenes, benzoquinones, coumarins, flavonoids, terpenoids,

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strigolactones, phenolic acids, tannins lignin, fatty acids and nonprotein aminoacids. A wide range of these biochemicals are synthesized during the shikimate pathway (Hussain and Reigosa, 2011) or, in the case of essential oils, from the isoprenoid pathway. Allelochemicals can be classified into 10 categories (Li *et al*., 2010) according to their different structures and properties:

1. Water-soluble organic acids, straight-chain alcohols, aliphatic aldehydes, and ketones
2. Simple lactones
3. Long-chain fatty acids and polyacetylenes
4. Quinines (benzoquinone, anthraquinone and complex quinines)
5. Phenolics
6. Cinnamic acid and its derivatives
7. Coumarins
8. Flavonoids
9. Tannins
10. Steroids and terpenoids (sesquiterpene, lactones, diterpenes, and triterpenoids).

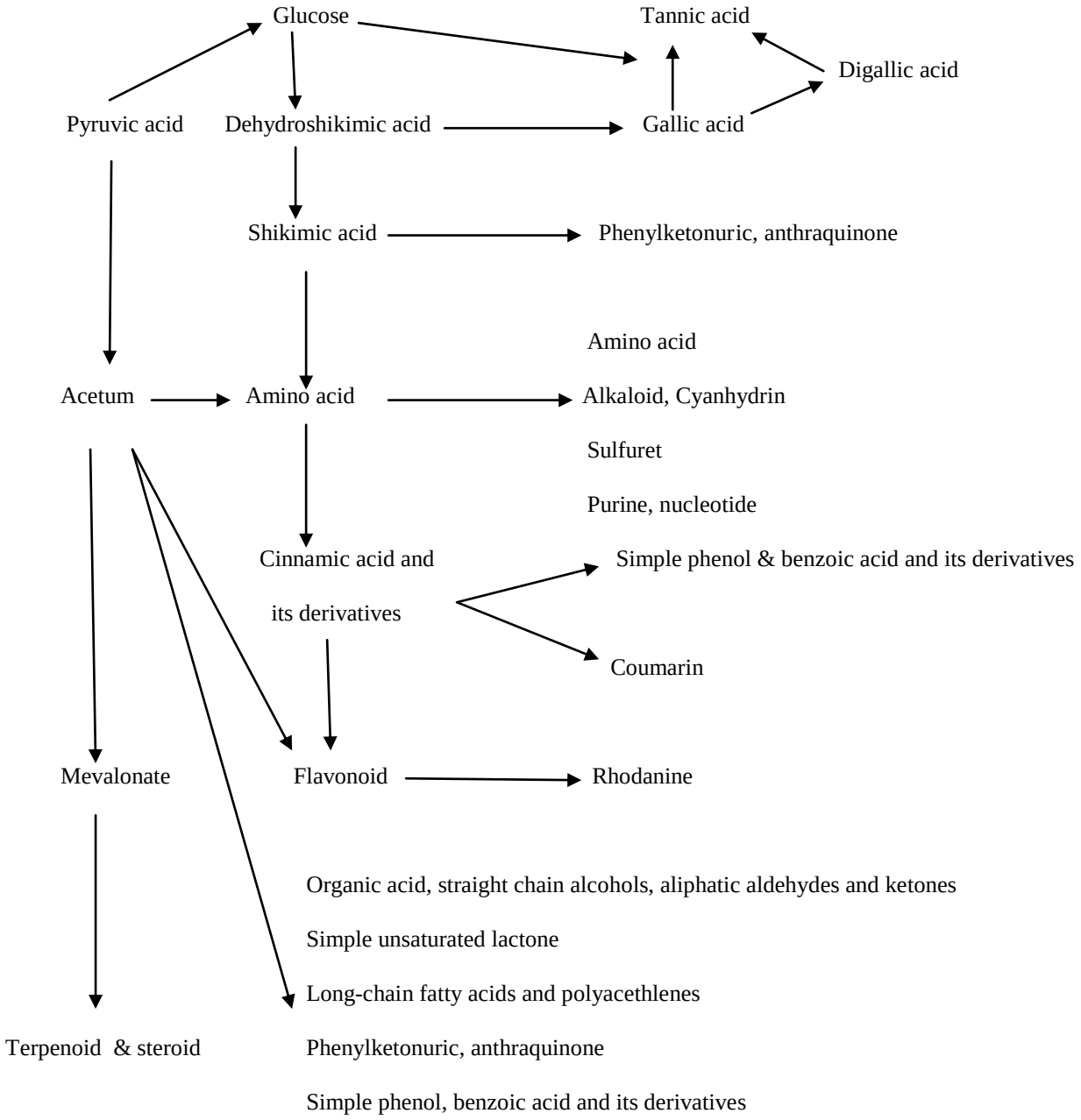

Figure 2: Major pathways leading to production of the various categories of allelochemicals (Source: Wang *et al*., 2006).

Based on the morphology of the plant, the weeds are also classified in to three categories. This is the most widely used classification by the weed scientists.

(a) Grasses: All the weeds come under the family Poaceae are called as grasses which are characteristically having long narrow spiny leaves. The examples are Sawa millet (*Echinochloa colona*), Indian doab (*Cynodon dactylon*) etc.

(b) Sedges: The weeds belonging to the family Cyperaceae come under this group. The leaves are mostly from the base having modified stem with or without tubers. The examples are Purple Nutsedge (*Cyperus rotundus*),Grasslike Fimbry (*Fimbrystylis miliacea*) etc.

(c) Broad leaved weeds: This is the major group of weeds as all other family weeds come under this except that is discussed earlier. All dicotyledon weeds are broad leaved weeds. The examples are Black Nightsade (*Solanum nigrum* L.), Goatweed (*Ageratum conyzoides* L.), Indian mallow (*Abutilon indicum* (Linn.) Sweet), Velvetleaf (*Abutilon theophrasti* Medik.), Coffee senna (*Cassia occidentalis* L.) and Sicklepod *Cassia obtusifolia* L.) etc.

Allelopathic suppression of black nightshade (*Solanum nigrum* L.)

Allelopathic effects of Eucalyptus species have been widely reported and considered as a natural way for sustainable weed management. Phytotoxic effects of various solvent extracts (aqueous, methanolic, ethyl a cetate, acetonic and benzene) and different concentrations of extracts (0, 1.25, 2.5, 5 and 10 gram per liter) of *E. globulus* leaves against Solanum nigrum weed indicated that with increasing of extract concentration germination percentage and rate, root and shoot lengths and fresh and dry weights significantly decreased. (Ataollah *et al*., 2014). Sadeghi *et al*. (2010) reported that sunflower extracts reduced *S. nigrum* hypocotyl length, hypocotyl weight, radicle weight, seed germination and radicle length by as much as 56, 64, 61, 77 and 81% respectively, when compared with a water control. Increasing the water extract concentrations from 5 to 25g per 100 ml of water of all sunflower parts significantly increased the inhibition of *S. nigrum* germination, seedling length and weight. Uremis *et al*. (2009) reported that shoot and root extracts of rapeseed cultivars inhibited seed germination, seedling and root growth of *S. nigrum* are investigated in proportion related to the concentration of extracts. Arouiee et al. (2010) reported that the allelopathic effects of leaf extracts of *Thymus vulgaris, Lavadula sp, Rosmarinus officinalis and Eucalyptus citriodora* at five levels (0, 10, 20, 30 and 100 %) on seed germination and some growth characteristics of *Solanum nigrum* was investigated. The internode length and plant height, node number and leaves total chlorophyll content decreased with increasing rate of extracts. When dried alfalfa residues were mixed into vermiculite, germination, length of shoot and root of *Solanum nigrum*, were significantly inhibited as the dried residue concentration increased. More than 10% concentration of the dired residue caused 80% germination and growth inhibition (Yu *et al*., 1995).

Allelopathins	Source	References	Sensitive Weed
Solvent extracts	*Eucalyptus globules*	Ataollah *et al*., 2014	Black nightshade (*Solanum nigrum*)
Water extracts	Sunflower	Sadeghi *et al*., 2010	″
Root and shoot extracts	Rapeseed	Uremis *et al*., 2009	″
Leaf extracts	*Thymus vulgaris, Lavadula sp, Rosmarinus officinalis and Eucalyptus citriodora*	Arouiee *et al*.,2010	″
Dried residue	Alfalfa	Yu *et al*., 1995	″

Allelopathic suppression of Goatweed (*Ageratum conyzoides* L.)

Allelopathic effects of the aqueous extract of the leaf and seed of *Leucaena leucocephala* were tested on goatweed (*Ageratum conyzoides*). Germination, shoot length, root length and fresh weight of goatweed were reduced in response to respective increasing concentrations of the seed and leaf extracts (Ishak and Sahid, 2014). Biswas *et al*. (2014) reported that *Brassica* crops were uprooted at 30 days after sowing (DAS) and incorporated to the soil @ 0.5 kg m^{-2} as per treatment. Wheat seeds were sown on December 04, 2007 using 20 cm line to line distance. *Ageratum conyzoides* was not found in the wheat field. Sharma *et al*. (2017) reported that aqueous leaf extracts of *Withania somnifera* in 100% w/v concentrations were sprayed on three month old seedlings of weeds at an interval of 5 d. All the aqueous extracts significantly suppressed shoot length, root length, fresh weight and dry weight

of *Ageratum conyzoides.* Xuan *et al*. (2016) reported that the allelopathic potential of sweet potato varieties was determined to control invasive weed goatweed (*Ageratum conyzoides* L.) in crop fields. The phytotoxic potential of eugenol, a major component from the essential oil of clove [*Syzygium aromaticum* (L.) Merrill and Perry], was investigated against *Ageratum conyziodes* L. The effect of eugenol (50–1,000 μM) on the growth and development of seedlings after 7 days of treatment was studied in terms of percent germination, root and shoot length, total chlorophyll content and cellular respiration (Ahuja *et al*., 2015). A significant effect on weed emergence and early seedling growth was observed in a dose-response based laboratory bioassay in a sand culture. Emergence of *A. conyzoides* was completely inhibited at 100 μg/g sand content of citronellal. Seeds of *A. conyzoides* failed to emerge even at 50 μg/g content. Root length was inhibited more caused visible injury in the form of chlorosis and necrosis, leading to wilting and even death of *A. conyzoides* (Singh *et al*. (2006).

Allelopathins	Source	References	Sensitive Weed
Aqueous extracts of leaf and seed	*Leucaena leucocephala*	Ishak and Sahid, 2014	Goatweed (*Ageratum conyzoides* L.)
Soil incorporation in wheat field	*Brassica spp.*	Biswas *et al*., 2014	″
Aqueous leaf extracts	*Withania somnifera*	Sharma *et al*., 2017	″
Stem extracts	*Ipomoea batatas*	Xuan *et al*., 2016)	″
Eugenol	*Syzygium aromaticum* Procured in pure form	Ahuja *et al*., 2015	″
Citronellal		Singh *et al*., 2006	″

Allelopathic suppression of Sicklepod (*Cassia obtusifolia* L.) and Coffee Senna (*Cassia occidentalis* L.)

The allelopathic potential of wild radish was evaluated in controlled environments by determining if an aqueous extract from oven-dried wild radish shoots suppressed germination and radicle growth of *Cassia obtusifolia* (Norsworthy, 2003). Raoof and Siddiqui (2012) reported the allelopathic effects of *Tinospora cordifolia* weed on seed germination and seedling growth of sicklepod. Leaf extracts of *Psidium guajava* were used to investigate allelopathic potential against seed germination and growth of *Cassia occidentalis*. (Kawawa *et al*., 2016). (Singh *et al*. (2006) reported that upon citronellal treatment, there was loss of chlorophyll pigment and reduction in cellular respiration indicating the impairment of photosynthetic and respiratory metabolism. Scanning electron microscopic studies in *C. occidentalis* leaves upon treatment of citronellal revealed disruption of cuticular wax, clogging of stomata and shrinkage of epidermal cells at many places. The phytotoxic potential of eugenol, a major component from the essential oil of clove [*Syzygium aromaticum* (L.) Merrill and Perry], was investigated against *Cassia occidentalis* The effect of eugenol (50–1,000 μM) on the growth and development of seedlings after 7 days of treatment was studied in terms of percent germination, root and shoot length, total chlorophyll content and cellular respiration (Ahuja *et al*., 2015). The effect of volatile oil from leaves of *Eucalyptus citriodora* against *Cassia occidentalis* was investigated. In a laboratory bioassay seed germination, chlorophyll content and cellular respiration *Cassia occidentalis* were significantly reduced in response to the different concentrations of the eucalypt oil (Batish *et al*., 2004). Again a similar study was undertaken to assess the allelopathic potential of citonellol, a volatile monoterpene found in *Eucalyptus citriodora, E. globulus, Ocimum basilicum, Zingiber officinale, Coriandrum sativum, Citrus limon* and several other aromatic plants, against *Cassia occidentalis*. Citonellol was found to appreciably inhibit the germination and seedling growth even at very low concentrations. Not only the growth, even the content of total chlorophyll and cellular respiration in *Cassia occidentalis* was reduced quite significantly, thereby indicating that citronellol has a negative effect on the photosynthetic efficiency and the energy metabolism of *Cassia occidentalis* (Vaid, 2016a). A similar study was also carried out by same researcher to assess the inhibitory potential of linalool, a volatile monoterpene found in many flowers and spice plants against coffee-weed, *Cassia occidentalis*. Linalool was found to have a significant inhibitory effect on the germination and early seedling growth of the test

weed. The physiological parameters *viz.* the content of total chlorophyll and percent cellular respiration of the test weed were also reduced to varying degrees compared to control, indicating a negative effect of the test monoterpene on the photosynthetic efficiency and energy metabolism of *Cassia occidentalis* (Vaid, 2016b).

Allelopathins	Source	References	Sensitive Weeds
Aqueous extracts of shoot	Wild radish	Norsworthy, 2003	*Cassia obtusifolia* (Sicklepod)
Aqueous extracts of root	*Tinospora cordifolia*	Raoof and Siddiqui, 2012	″
Leaf extracts	*Psidium guajava*	Kawawa *et al*., 2016	*Cassia occidentalis* (Coffee senna)
Citronellal	Procured in pure form	Singh *et al*., 2006	″
Eugenol	*Syzygium aromaticum*	Ahuja *et al*., 2015	″
Eucalypt oil	*Eucalyptus citriodora*	Batish *et al*., 2004	″
Citronellol	Aromatic plants	Vaid, 2016a	″
Linalool	Spice plants	Vaid, 2016b	″

Allelopathic suppression of Indian Mallow [*Abutilon indicum* (Linn.) Sweet] and Velvetleaf (*Abutilon theophrasti* Medik.)

Seed germination and seedling growth of velvetleaf were inhibited by the wheat-straw extracts (Steinsiek *et al*., 1982). Benzyl isothiocyanate (BITC) was extracted from mature papaya *(Carica papaya* L.) seeds and applied to to etiolated velvetleaf seedlings at 4×10^{-4} M, 100% died in 2 days (Wolf *et al*., 1984). Liu *et al*. (2006) reported that the allelopathic effect of aqueous extract from the aerial part and root of *T. repens* under different concentrations on the germination rate, physiological and biochemical mechanism of germinating seeds of *Abutilon theophrasti* Medic. was studied. Citronellol and citral exhibited inhibiting germination of velvetleaf (Liu *et al*., 2006). Fanaei *et al*. (2013) reported that chlorophyll content of *Abutilon theophrast* decreased by using of extract different concentration of Sweet basil. Younesabadi *et al*. (2014) reported that the inhibitory effects of water extracts of *A. camelorum*, *A. annua*, *I. graveolens*, *X. strumarium*, *C. bonariensis* and *S. nigrum* on *A. theophrasti* growth and germination. Decaying leaves and inflorescences, and field soils collected beneath *Chenopodium ambrosioides* and *C. murale* were examined in terms of the inhibition of seed germination and seedling growth of *Abutilon indicum*. The respective plant-parts from the two species were chemically analysed and the presence of three terpenes (p-cymene, ascaridole and aritazone) from *C. ambrosioides* and an organic acid (oxalic acid) from *C. murale* were implicated in the allelopathic effect (Datta and Ghosh, 1987).

Allelopathins	Source	References	Sensitive Weeds
Straw extracts	Wheat	Steinsiek *et al*., 1982	Velvetleaf (*Abutilon theophrasti*)
Benzyl isothiocyanate (BITC)	Papaya (*Carica papaya* L.)	Wolf *et al*., 1984	″
Aqueous extracts of aerial part and root	*Trifolium repens*	Liu *et al*., 2006	″
Citronellol and Citral	Procured in pure form	Liu *et al*., 2006	″
Water extracts	Sweet basil	Fanaei *et al*., 2013	″
Water extracts	*A. camelorum*, *A. annua*, *I. graveolens*, *X. strumarium*, *C. bonariensis* and *S. nigrum*	Younesabadi *et al*., 2014	″

Decaying leaves and inflorescences	*Chenopodium ambrosioides* and *C. murale*	Datta and Ghosh, 1987	Indian mallow (*Abutilon indicum*)

REFERENCES

Ahuja, N., Batish, D. R., Singh, H. P. and Kohli, R. K. (2015). Herbicidal activity of eugenol towards some grassy and broad-leaved weeds. *Journal of Pest Science.* **88(1)**: 209-218.

Arouiee, A., Quasemi, S., Azizi, M. and Nematy, H. (2010). Allelopathic effects of some medicinal plants extracts on seed germination and growth of common weeds in mashhad area. *The 8th International Symposium on Biocontrol and Biotechnology Proceedings* pp139-147.

Ataollah, R., Dejam, M. and Khaleghi, S. S. (2014). Phytotoxic effects of *Eucalyptus globulus* leaf extrat on *Solanum nigrum. South west J Hortic Biol Environ*. **5(1)**: 43-53

Batish, D. R., Setia, N., Singh, H. P. and Kohli, R. K. (2004). Phytotoxicity of lemon-scented eucalypt oil and its potential use as a bioherbicide. *Crop Protection*. **23(12)**: 1209-1214.

Biswas, P. K., Morshed, M. M., Ullah, M. J. and Irin, I. J. (2014). Allelopathic effect of *Brassica* on weed control and yield of wheat. *Bangladesh Agron. J.* **17(1)**: 73-80.

Datta, S. C. and Ghosh, K. N. (1987). Allelopathy in two species of *Chenopodium* inhibition of germination and seedling growth of certain weeds. *Acta Societatis Botanicorum Poloniae*. **56(2)**: 257-270.

Dayan, F. E., Cantrell, C. L. and Duke, S. O. (2009). Natural products in crop protection. *Bioorganic & medicinal chemistry*. **17**: 4022-4034.

Fanaei, M., Aboutalebi, A. and Hasanzadeh, H. (2013). Allelopathic effects of Sweet basil (*Ocimum basilicum*) extract and essence on chlorophyll content of three weed species. *Intl. Res. J. Appl. Basic. Sci.* **4 (6)**: 1511-1513.

Gatti, A. B., Perez, S. C. J. G. D. and Lima, M. I. S. (2004). Atividade alelopática de extratos aquosos de Aristolochia esperanzae O. Kuntze na germinação e no crescimento de *Lactuca sativa* L. e *Raphanus sativus* L. *Acta Botanica Brasilica*.

Hussain, M. I. and Reigosa, M. J. (2011). Allelochemical stress inhibits growth, leaf water relations, PSII photochemistry, non-photochemical fluorescence quenching, and heat energy dissipation in three C3 perennial species. *Journal of Experimental Botany*. , **62(13)**: 4533-4545.

Iqbal, A, and Fry, S. C. (2012). Potent endogenous allelopathic compounds in *Lepidium sativum* seed exudate: effects on epidermal cell growth in *Amaranthus caudatus* seedlings. *Journal of Experimental Botany*. **63(7)**: 2595-2604.

Ishak, M. I. and Sahid, I. (2014). Allelopathic effects of the aqueous extract of the leaf and seed of *Leucaena leucocephala* on three selected weed species. *AIP Conf. Proc*. pp 659-664.

Kawawa, R. C. A., Muyekho F. N., Obiri, J. F. , Agevi, H. and Obiet, L. (2016). The allelopathic impact of *Psidium guajava* L., leaf extracts on the germination and growth of *Cassia occidentalis* L.,seeds. *Journal of Agriculture and Veterinary Science*. **9(7)**: 101-105.

Li, Z. H., Wang, Q., Ruan, X., Pan, C. D. and Jiang, D. A. (2010). Phenolics and Plant Allelopathy. *Molecules*. doi:10.3390/molecules15128933, **15(12)**: 8933-8952.

Liu, Y., Wang, Jin-xin., Hu, Y., Dong, Xiao-wen. and Zhang, M. (2006). Allelopathy of *Trifolium repens* L. on *Abutilon theophrasti* Medic.and *Echinochloa crusgalli* L. *Acta Phytophylacica Sinica*. **33(4)**.

Macías, F. A., Molinillo, J. M., Varela, R. M. and Galindo, J. C. (2007). Allelopathy—a natural alternative for weed control. *Pest Management Science*. **63**: 327-348.

Molisch, H. (1937). *Der Einfluss einer Pflanze auf die andere-Allelopathie.* Fischer, Jena.

Norsworthy, J. K. (2003). Allelopathic potential of wild radish (*Raphanus raphanistrum*). *Weed Technology*. **17(2)**: 307-313.

Putnam, A. R., and Duke, W. B. (1978). Allelopathy in agroecosystems. *Annual Review of Phytopathology*. **16**: 431-451.

Raoof, K. M. A. and Siddiqui, M. B. (2012). Allelopathic effect of aqueous extracts of different parts of *Tinospora cordifolia* (Willd.) Miers on some weed plants. *Journal of Agricultural Extension and Rural Development*. **4(6)**: 115-119.

Sadeghi, S., Rahnavard, A. and Ashrafi, Z. Y. (2010). Allelopathic effect of Helianthus annuus (sunflower) on Solanum nigrum (black nightsade) seed germination and growth in laboratory condition. *Journal of Horticultural Science & Ornamental Plants*. **2(1)**: 32-37.

Sharma, M., Kaur, R. and Puri, S. (2017). Bio-herbicidal efficiency of *Withania somnifera* against important himalayan weeds. *Int J Pharm Pharm Sci*. **9(3)**: 88-97.

Singh, H. P., Batish, D. R., Kaur, S. and Kohli, R. K. (2006). Phytotoxicity of the volatile monoterpene citronellal against some weeds. *Z. Naturforsch*. **61c**: 334-340.

Steinsiek, J. W., Oliver, L. R. and Collins, F. R. (1982). Allelopathic potential of wheat (*Triticum aestivum*) straw on selected weed species. *Weed Science*. **30**: 495-497.

Uremis, I., Arslan, M., Sangun, M. K., Uygur, V. and Isler, N. (2009). Allelopathic potential of rapeseed cultivars on germination and seedling growth of weeds. *Asian Journal of Chemistry*. **21(3)**: 2170-2184.

Vaid, S. (2016a). Phytotoxicity of citronellol against two weedy species. *Int.J Curr.Microbiol. App. Sci.* **5(1)**: 560-564.

Vaid, S. (2016b). Potential of linalool for inhibition of *Cassia occidentalis*. *Int.J.Curr.Res.Aca.Rev.* **4(1)**: 155-159.

Vaughn, S. F. and Spencer, G. F. (1993). Volatile monoterpenes as potential parent structures for new herbicides. *Weed Science*. **41**: 114-119.

Wang, Q., Ruan, X., Li, Z. H. and Pan, C. D. (2006). Autotoxicity of plants and research of coniferous forest autotoxicity. *Sci. Sil. Sin.***43**: 134-142.

Weir, T. L, Park, S-W. and Vivanco, J. M. (2004). Biochemical and physiological mechanisms mediated by allelochemicals. *Current Opinion in Plant Biology*. **7(4)**: 472-479.

Wolf, R. B., Spencer, G. F. and Kwolek, W. F. (1984). Inhibition of velvetleaf *(Abutilon theophrasti)* germination and growth by benzyl isothiocyanate, a natural toxicant. *Weed Science*. **32**: 612-615.

Xuan, T. D., Minh, T. N., Trung, K. H. and Khanh, T. D. (2016). Allelopathic potential of sweet potato varieties to control weeds: *Imperata cylindrica*, *Bidens pilosa* and *Ageratum conyzoides*. *Allelopathy Journal*. **38(1)**: 41-54.

Younesabadi, M., Habibian, L. and Savarinejad, A. R. (2014). Using of plant extracts in control of Abutilon theophrasti Medicus. *International Journal of Farming and Allied* Sciences. **3(5)**: 483-488.

Yu, C. Y., Jeon, I. S., Chung, I. M., Hur, J. H. and Kim, E. H. (1995). The allelopathic effect of Alfalfa residues on crops and weeds. *Korean Journal of Weed Science*. **15(2)**: 131-140.

RESEARCH ARTICLE

INFLUENCE OF SEED STORAGE CONDITION ON SEED MOISTURE CONTENT AND GERMINATION IN *IMPATIENS TALBOTII* HOOK.

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Abstract: Lesser known species *Impatiens talbotii* is a rare, endangered endemic ephemeral restricted to the northern part of central Western Ghats. Life of *I. talbotii* will terminate within six months. In the present study, species is studied to understand its seed viability upon storage which will accounts in species conservation. Seeds were stored at four different relative humidity regimes in two different temperatures. Study revealed that there was a gradual decrease in seed moisture as well germination attributes in all the storage condition upon storage period. Seeds stored under ambient humidity at cold temperature maintained reliable moisture content and germination till the end of storage period. Significantly high germination per cent, rate of germination, seedling length and seedling vigour index was observed in seeds stored in cold temperature than the seeds stored in ambient temperature. Higher germination of 83 per cent was observed in seeds stored at ambient RH under cold temperature and least germination of 3 per cent was observed in seeds stored at 90-95 % RH under ambient temperature after 30 days of storage. After 180 days of storage the high vigour of 1890 was observed in ambient RH under cold storage and low vigour of 83 was noticed in seeds stored at 90-95% RH under ambient temperature. Seed storage at ambient humidity in cold storage is best storage condition to *Impatiens talbotii* for long term storage.

Keyword: *Impatiens talbotii*, Relative humidity, Moisture content, Temperature

INTRODUCTION

Impatiens talbotii is an ephemeral herbaceous plant under the family Balsaminaceae. Genus *Impatiens* produces beautiful ornamental flowers which play an important role in the ecosystem as a nectar producing plants for several butterflies, bees, moths *etc*. Balsaminaceae is one of the largest groups among flowering plants comprising more than 1000 species in the world and in India the genus is represented by more than 209 species of which 148 are endemic (Vivekananthan *et al*., 1997). Of the total species, about 106 species are in peninsular India, of which 103 spp. are endemic and confined to Western Ghats. Considering its high endemism, restricted to narrow habitats and also severe threat for its survival, many *Impatienses* of Western Ghats has been categorized for their threat status as per IUCN Red List Categories and Criteria. About 51 per cent of the total species in Western Ghats are categorized as threatened, 40 species fall under the category of critically endangered, about 33 endangered and 16 are under vulnerable status (Bhaskar, 2006). The genus *Impatiens* is distributed throughout the wet tropical and sub-tropical regions of Asia and Africa, while few species are recorded from the temperate regions of Asia, Europe and North America (Ganesh *et al*., 2007).

Impatiens talbotii is a typical endemic balsam plant distributed in a narrow belt of Western Ghats and reported only from Uttara Kannada and Shimoga districts of Karnataka. *Impatiens talbotii* was first recorded by Hooker in 1906 based on Talbot's collection from Devimane ghat in Uttara Kannada District (Jyosna *et al*., 2009). As per the Red Data Book of Indian plants, it is a rare endemic species and endangered according to IUCN threat status. *Impatiens* is commonly grown in moist grounds with partial shade in large groups and appears in either sides of the steep path. Most of them are terrestrial and few are epiphytic. All *Impatiens* are annuals usually appear in the monsoon except *I. balsamina* which is a perennial and produce their beautiful flowers and seeds throughout the year. However; it is cultivated in the gardens as an ornamental plant. Plant appears in the month of June and flowers during July to September. The growth ceases during October and thereafter it terminates its life cycle.

Lack of knowledge of seed biology and seed handling techniques and other important aspects includes population dynamics; reproductive ability and their fitness of organisms are hard to conserve them from the risk of extinction. The main intention of this attempt is to understand the storability and retention of moisture, eventually helps in conservation of rare and endangered ephemeral *Impatiens talbotii.*

Since the life of a seed largely revolves around its moisture contents it is necessary to dry seeds to safe moisture content. However, moisture content depends upon storage length and storage structure. Relative humidity and temperature are the most important factors determining the storage life of seed. Storage is the preservation of viable seeds from the time of collection until they are required for sowing (Holmes and Buszewicz, 1958). Successful long-term storage also depends on storage conditions and treatment and quality of the seed. Storage of seed is advantageous for reforestation programs, research and genetic conservation. Maintaining the initial genetic and physiological quality of seed is one objective of storage.

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MATERIAL AND METHODS

The present experiment was carried out in Forest Biology and Tree Improvement laboratory, College of Forestry Sirsi, Uttara Kannada District of Karnataka during the year 2016 17. Plants are spread in groups in and around temple, bus stand, market places, abandoned paddy fields, undergrowth of arecanut plantations, along the road sides, garbage dumping areas *etc*. Seeds were collected from in and around Sirsi town.

One season old seeds were stored under two different storage temperatures (Ambient and cold condition) and four different relative humidity regimes viz., 0, 45-50, 90-95 and control). Seeds were stored under different RH regime in both temperatures. To maintain 0% RH throughout the storage period, the special storage chamber was maintained by using silica gel in desiccators. Silica gel was filled below the perforated plate in desiccators and seeds were kept on the plate. For 45- 50 % RH the special storage chamber was maintained by using Ca $(NO_3)_2$ $4H_2O$ in desiccators. 90-95% RH maintained throughout the storage period in storage chamber was maintained by using $CuSO_4$ $5H_2O$ in desiccators. Saturated solution of Ca $(NO_3)_2$ $4H_2O$ and $CuSO_4$ $5H_2O$ was filled below the perforated plate to maintain 40-45% and 90-95 % RH respectively (Plate 1). Seed were stored at laboratory where ambient RH was maintained. The experiment was laid out in Factorial Complete Randomized Design (FCRD) with three replications. Seeds were stored in all RH regimes throughout the storage period. 300 seeds were drawn from each storage condition at 30 days of interval for six months. Moisture per cent was calculated and set of seed was sown for germination from all the storage condition in each interval. The experiment was laid out in Factorial Complete Randomized Design (FCRD). Form each storage condition seeds were sown for germination in three replications and seeds were used for moisture per cent estimation in three replications in all the intervals. Seed germination and seedling quality parameters were recorded and calculated (Anon., 1996).

RESULTS AND DISCUSSION

Seeds are living creatures and keeping them viable over the long term requires adjusting storage moisture and temperature appropriately. The level of dryness and coldness depends mostly on the longevity that required and the investment in infrastructure that is affordable. Relative humidity and temperature are the most important factors determining the storage life of seeds. Thus the maintenance of seed moisture content during storage is function of relative humidity and storage temperature. Conserving the seeds as germplasm is very important in conservation of rare and endangered species. Though *I.talbotii* is an endangered and endemic plant, it is necessary to preserve the plants propagules for the enhanced establishment.

There was significant difference in seed moisture content due to the storage temperature during storage. Initially the seed moisture content was 13.1 per cent (Table-1). Among the storage temperatures, seeds stored at ambient temperature retained more moisture content of 13.79 compare to the cold storage after 30 days of storage. The seed moisture content significantly varied throughout the storage. There was significant and greater reduction in moisture content (5.5%) after 90 days of storage under ambient temperature over the cold storage. Seeds stored under cold temperature significantly retained the high moisture content and gradual reduction in moisture content taken place during the storage. This may be due to the higher desiccation of seed moisture in ambient temperature. In cold storage seeds were exposed to lower temperature hence the amount of seed moisture desiccation is less. Similar results are corroborate with findings of Singh *et al.* (1997) in *Azadirachta indica.*

Significant differences in seed moisture content due to the different relative humidity levels during storage. Among the four levels RH, seed stored under 90-95 % RH retained high moisture content of 18.25 per cent compare to the other RH levels after 30 and 60 days of storage. Significant reduction in seed moisture content after 90 days of storage under 90-95% RH (9.76%) over the other RH levels. Seeds stored under 0%, 45-50% and ambient RH significantly retained the moisture content and gradual reduction in moisture content occur till 150 days after storage. Constant maintenance of moisture content was observed in seeds stored under 45-50% RH and ambient RH after 180 days of storage (17.13% and 11.37% respectively). In general, irrespective of storage period, decrease in moisture content was observed with decrease in the RH levels.

Seeds stored at 90-95% RH under ambient temperature retained high moisture content of 20.33 and 27.99 per cent after 30 and 60 days of storage respectively. There was greater reduction to 6.60 % from the 10.87% in seed moisture content was observed in seeds stored in 0% RH under ambient temperature. Seeds stored at 45- 50% RH and ambient RH under both ambient temperature and cold temperature retained the moisture content and gradual reduction in seed moisture content noticed throughout the storage. The seeds stored at 90-95% RH under ambient temperature were completely deteriorated after 60 days of storage. (Fig. 1 and 2).

There was significant difference in germination percentage due to the temperature during storage (Table 2). Among the storage temperatures seeds stored at cold temperature recorded high germination of 41 per cent after 30 days of storage over the seeds

stored at ambient temperature. The same trend was continued throughout the storage period; 32, 27, 20, 19 and 15 per cent germination was observed in 60, 90, 120, 150 and 180 days after storage respectively in cold temperature. Whereas seed stored under ambient temperature, 24, 11, 8, 6, 4 and 3 per cent germination was observed in 30, 60, 90, 120, 150 and 180 days after storage respectively. The greater decline to 11 per cent germination after 60 days of storage from the 24 per cent germination at 30 days of storage was observed in seeds stores under ambient temperature. There was significant and gradual decrease in germination per cent in seeds stored under cold temperature. Significantly high germination per cent, rate of germination, mean daily germination, was observed in seeds stored in cold temperature than the seeds stored in ambient temperature. In conformity, Guedes *et al*., 2012, reported in *Tabebuia caraiba* Mart. seeds stored at cold temperature showed significantly higher results in seeds moisture, percentage of emergence and emergence rate over all other storage environment in all the storage period.

Seeds stored at ambient RH recorded high germination of 62 per cent and the lowest germination was recorded in seeds stored at 90-95% RH after 30 days of storage. The greater reduction in germination was observed in seed stored at 0% RH i.e., reduced to 8 per cent after 60 days of storage from the 28 per cent germination at 30 days after storage. There was no germination was observed in seeds stored at 90-95% RH after 120 days of storage. Significant and gradual reduction in seed germination was observed in seeds stores at ambient RH. In general, storage period increases, decline in seed germination was observed in all the RH levels.

Significantly higher germination of 83 per cent was observed in seeds stored at ambient RH under cold temperature and least germination of 3 per cent was observed in seeds stored at 90-95 % RH under ambient temperature after 30 days of storage. Greater reduction in germination was observed in seeds stored at 0% RH under both the temperature after 60 days of storage. After 90 days of storage there was no germination of seed found in seeds stored at 0% RH under both the temperatures. Similarly there was no germination was observed in seeds stored at 90-95% RH under cold storage. Significant and gradual reduction in germination percent was observed in seeds stored at ambient RH under cold storage.

There was significant difference in rate of germination due to the temperature during seed storage. Among the storage temperatures, high rate of germination (1.28) was found in seeds stored under cold temperature after 30 days of storage over the ambient temperature. Significant difference was observed in rate of germination due to the different relative humidity regimes during the seed storage. The high rate of germination (1.60) was observed in seeds stored at ambient RH after 30 days of storage over the other RH levels (Table-3). Among all the storage conditions seed stored at ambient RH under cold temperature recorded high rate of germination (2.53) over the other storage condition. Seed stored at 0 % RH under both the temperature, great reduction of germination rate was observed after 60 days of storage. There was significant and gradual decrease in rate of germination was observed in seeds stored at ambient RH under cold storage.

Among the storage temperatures, seed stored at cold temperature recorded maximum seedling length of 32.08 cm after 30 days of storage compare to the cold storage (23.75 cm). There was significant and greater reduction of seedling length after 90 days of storage was observed under ambient temperature over the cold storage. The cold storage recorded reduced seedling length compared to room temperature. These results are in conformity with findings of Bhardwaj *et al*., (2014) in *Rheum austral*.

Seedling length varied significantly due to the different relative humidity levels during seed storage (Table-4). Among the RH levels, seed stored at ambient RH recorded maximum seedling length of 36.17 cm after 30 days of storage compared to other RH levels. There was significant and greater reduction of seedling length after 90 days of storage at 90-95% RH. Seeds stored at ambient and 45-50% RH showed significant and gradual reduction of seedling length over the storage period. In general, as the storage period advancement, decrease in seedling length was noticed in all the RH levels.

The interaction of storage temperatures and RH levels showed significant differences for seedling length during storage. Among all the storage conditions, seeds stored at ambient RH under cold temperature recorded maximum seedling length of 42.33 cm after 30 days of storage over the other storage condition. There was significant and gradual decrease in seedling length was observed in all the storage condition. In general, decreased seedling length was observed with increase in storage period.

Seeds stored at cold temperature recorded high seedling vigour of 1450 after 30 days of storage compare to the cold storage (638)(Fig.3). Reduction in seedling vigour after 90 days of storage was observed under ambient temperature over the cold storage. Seeds stored under cold temperature showed significant and gradual reduction of seedling vigour over the storage period. As advancement in the storage period, decline in seedling vigour was observed in both the storage temperatures. Among the RH levels, seed stored at ambient RH recorded high seedling vigour of 2210 after 30 days of storage compare to other RH levels. There was significant and higher reduction of seedling vigour after 90 days of storage at 0% RH (reduced to 199 after 60 days of seedling storage from 790 at 30 days after storage). Seeds stored at ambient RH showed significant and gradual reduction of seedling vigour over the storage period. The slow loss of viability under cold

condition may possibly due to reduced rate of metabolic activities and inactivation of enzymes at low temperature thus helping to retain viability. Considerably low germination per cent, mean daily germination, seedling length and seedling vigour was observed in seeds stored in ambient temperature with different relative humidity. This may be due the fluctuating external environment. This fluctuation affects the seed quality as well it cause deterioration of seed (Pradhan and Badola., 2012).

The interaction of storage temperatures and RH levels found significant for seedling vigour. Among all the storage conditions, seeds stored at ambient RH under cold temperature recorded high vigour (3375) after 30 days of storage over the other storage condition. After 180 days of storage the high vigour of 1890 was observed in ambient RH under cold storage and low vigour of 83 was noticed in seeds stored at 90-95% RH under ambient temperature. There was significant and gradual decrease in seedling vigour was observed in all the storage condition.

Table 1. Influence of temperature and relative humidity on seed moisture content during storage in *Impatiens talbotii*

Storage condition	Moisture content (%)					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**
Factor I : Storage Temperature (A)						
A_1 (Ambient temparature)	13.79 (21.80)	13.35 (21.43)	5.52 (13.59)	4.94 (12.89)	4.38 (12.07)	4.20 (11.83)
A_2 (Cold temperature)	13.57 (21.61)	12.37 (20.59)	11.57 (19.89)	10.1 (18.55)	9.76 (18.20)	9.14 (17.60)
S. Em. ±	**0.06**	**0.29**	**0.31**	**0.12**	**0.11**	**0.14**
C. D. @ 1%	**0.18**	**0.87**	**0.93**	**0.36**	**0.33**	**0.43**
Factor II : Relative Humidity (B)						
B_1 (at 0 % RH)	10.68 (19.08)	7.65 (16.06)	6.94 (15.27)	5.9 (14.03)	5.40 (13.44)	4.71 (12.53)
B_2 (at 45-50% RH)	14.16 (22.10)	10.75 (19.14)	8.79 (17.25)	8.12 (16.55)	7.38 (15.77)	17.13 (15.49)
B_3(at 90-95 % RH)	18.25 (25.29)	22.78 (28.51)	9.76 (18.21)	8.08 (16.52)	7.90 (16.32)	7.83 (16.25)
B_4(at ambient RH)	11.63 (19.94)	10.27 (18.69)	8.68 (17.14)	8.12 (16.55)	7.58 (15.98)	11.37 (19.70)
S. Em. ±	**0.08**	**0.41**	**0.44**	**0.17**	**0.15**	**0.20**
C.D. @ 1%	**0.25**	**1.23**	**1.32**	**0.51**	**0.46**	**0.60**
Interaction (A × B)						
A_1B_1	10.87 (19.25)	6.60 (14.88)	5.89 (14.05)	4.63 (12.43)	3.77 (11.19)	3.40 (10.63)
A_1B_2	12.78 (20.94)	9.47 (17.92)	7.85 (16.27)	7.43 (15.82)	6.40 (14.65)	6.33 (14.58)
A_1B_3	20.23 (26.73)	-	-	-	-	-
A_1B_4	11.28 (19.63)	9.37 (17.82)	8.33 (16.78)	7.83 (16.25)	7.33 (15.71)	7.07 (15.42)
A_2B_1	10.49 (18.90)	8.71 (17.17)	7.99 (16.42)	7.12 (15.47)	7.03 (15.38)	6.01 (14.20)
A_2B_2	15.53 (23.21)	12.04 (20.30)	9.73 (18.18)	8.80 (17.26)	8.37 (16.81)	7.93 (16.36)
A_2B_3	16.27 (23.79)	17.57 (24.78)	19.53 (26.22)	16.17 (23.71)	15.80 (23.42)	15.67 (23.32)
A_2B_4	11.97 (20.24)	11.17 (19.52)	9.03 (17.49)	8.40 (16.85)	7.83 (16.25)	6.95 (15.28)
S. Em. ±	**0.12**	**0.58**	**0.62**	**0.24**	**0.22**	**0.28**
C.D. @ 1%	**0.36**	**1.75**	**1.86**	**0.73**	**0.65**	**0.85**

***figures in parentheses indicate arc sine values , **DAS – Days after Storage**

Table 2. Influence of temperature and relative humidity on germination percentage during storage in *Impatiens talbotii*

Storage condition	Germination percentage					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**
Factor I : Storage Temperature (A)						
A_1 (Ambient temperature)	24 (29.28)	11 (20.05)	08 (15.89)	06 (13.98)	04 (12.13)	03 (9.69)
A_2 (Cold temperature)	41 (39.72)	32 (34.30)	27 (31.20)	20 (26.74)	19 (25.78)	15 (23.12)
S. Em. ±	**2.46**	**0.89**	**1.71**	**0.90**	**0.67**	**0.82**
C. D. @ 1%	**7.44**	**2.69**	**5.18**	**2.71**	**2.21**	**2.49**
Factor II : Relative Humidity (B)						
B_1 (at 0 % RH)	28 (32.16)	08 (15.89)	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)
B_2 (at 45-50% RH)	27 (31.09)	18 (24.73)	14 (22.11)	08 (15.89)	05 (12.25)	02 (7.42)
B_3 (at 90-95 % RH)	13 (20.70)	08 (16.07)	04 (11.78)	00 (0.00)	00 (0.00)	00 (0.00)
B_4(at ambient RH)	62 (51.94)	54 (47.49)	50 (45.19)	45 (41.94)	42 (40.49)	35 (36.17)
S. Em. ±	**3.48**	**1.26**	**2.42**	**1.27**	**0.67**	**1.16**
C. D. @ 1%	**10.52**	**3.80**	**7.33**	**3.84**	**2.21**	**3.52**
Interaction (A × B)						
A_1B_1	28 (31.16)	5 (12.92)	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)
A_1B_2	23 (28.88)	12 (19.98)	07 (15.34)	7 (14.97)	3 (10.51)	00 (0.00)
A_1B_3	03 (10.51)	-	-	-	-	-
A_1B_4	41 (39.62)	30 (33.42)	23 (28.66)	17 (24.10)	14 (22.24)	11 (19.67)
A_2B_1	28 (32.16)	10 (18.43)	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)
A_2B_2	30 (33.21)	23 (28.88)	21 (27.51)	08 (16.78)	06 (13.78)	03 (10.51)
A_2B_3	22 (27.74)	15 (23.05)	08 (16.78)	00 (0.00)	00 (0.00)	00 (0.00)
A_2B_4	83 (65.90)	78 (62.26)	78 (61.80)	73 (58.48)	70 (56.79)	58 (49.80)
S. Em. ±	**4.92**	**1.78**	**3.43**	**1.80**	**0.94**	**1.65**
C. D. @ 1%	**14.88**	**5.37**	**10.37**	**5.43**	**3.12**	**4.98**

***figures in parentheses indicate arc sine values, **DAS – Days after Storage**

Table 3. Influence of temperature and relative humidity on germination rate in *Impatiens talbotii*

Storage condition	Germination Rate					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**
Factor I : Storage Temperature (A)						
A_1 (Ambient temperature)	0.57	0.36	0.30	0.23	0.11	0.05
A_2 (Cold temperature)	1.28	0.99	0.80	0.58	0.49	0.39
S. Em. ±	**0.13**	**0.09**	**0.12**	**0.08**	**0.03**	**0.03**
C. D. @ 1%	**0.40**	**0.28**	**0.35**	**0.23**	**0.08**	**0.08**
Factor II : Relative Humidity (B)						
B_1 (at 0 % RH)	0.19	0.29	0.00	0.00	0.00	0.00
B_2 (at 45-50% RH)	0.80	0.70	0.60	0.53	0.27	0.14
B_3 (at 90-95 %	0.38	0.32	0.23	0.00	0.00	0.00

RH)						
B_4(at ambient RH)	1.60	1.39	1.30	1.10	0.93	0.74
S. Em. ±	**0.19**	**0.13**	**0.16**	**0.11**	**0.04**	**0.04**
C. D. @ 1%	**0.56**	**0.40**	**0.49**	**0.33**	**0.12**	**0.11**
Interaction (A × B)						
A_1B_1	0.74	0.20	0.00	0.00	0.0	0.00
A_1B_2	0.82	0.62	0.59	0.53	0.1	0.00
A_1B_3	0.04	-	-	-	-	-
A_1B_4	0.67	0.62	0.60	0.40	0.3	0.22
A_2B_1	1.08	0.38	0.00	0.00	0.0	0.00
A_2B_2	0.79	0.77	0.73	0.52	0.4	0.28
A_2B_3	0.71	0.65	0.46	0.00	0.0	0.00
A_2B_4	2.53	2.16	1.99	1.80	1.5	1.26
S. Em. ±	**0.26**	**0.19**	**0.23**	**0.15**	**0.06**	**0.05**
C. D. @ 1%	**0.79**	**0.57**	**0.70**	**0.47**	**0.17**	**0.16**

****DAS – Days after Storage**

Table 4. Influence of storage temperature, relative humidity and storage period on seedling length in *Impatiens talbotii*

Storage condition	**Seedling Length (cm)**					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**
Factor I : Storage Temperature (A)						
A_1 (Ambient temperature)	23.75	21.50	12.29	12.49	12.92	6.33
A_2 (Cold temperature)	32.08	30.75	21.69	15.35	14.62	14.09
S. Em. ±	**1.57**	**0.43**	**0.31**	**0.21**	**0.26**	**0.24**
C. D. @ 1%	**4.76**	**1.30**	**0.99**	**0.63**	**0.79**	**0.71**
Factor II : Relative Humidity (B)						
B_1 (at 0 % RH)	27.50	26.33	0.00	0.00	0.00	0.00
B_2 (at 45-50% RH)	27.67	29.00	24.68	25.30	24.78	11.95
B_3 (at 90-95 % RH)	20.33	13.50	11.53	0.00	0.00	0.00
B_4(at ambient RH)	36.17	35.67	31.75	30.38	30.28	28.88
S. Em. ±	**2.23**	**0.61**	**0.43**	**0.29**	**0.37**	**0.33**
C. D. @ 1%	**6.72**	**1.83**	**1.31**	**0.89**	**1.12**	**1.00**
Interaction (A × B)						
A_1B_1	30.00	26.33	0.00	0.00	0.00	0.00
A_1B_2	26.67	28.33	23.00	24.13	25.37	0.00
A_1B_3	25.00	-	-	-	-	-
A_1B_4	31.00	30.33	26.17	25.83	26.3	25.30
A_2B_1	25.00	26.33	0.00	0.00	0.00	0.00
A_2B_2	28.67	29.67	26.37	26.46	24.20	23.90
A_2B_3	32.33	27.00	23.07	0.00	0.00	0.00
A_2B_4	42.33	40.00	37.33	34.93	34.27	32.46
S. Em. ±	**3.15**	**0.86**	**0.61**	**0.45**	**0.53**	**0.47**
C. D. @ 1%	**9.52**	**2.59**	**1.86**	**1.29**	**1.59**	**1.42**

Table 5. Influence of storage temperature, relative humidity and storage period on seedling vigour in *Impatiens talbotii*

Storage condition	**Seedling vigour**					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**180 DAS**
Factor I : Storage Temperature (A)						
A_1 (Ambient temperature)	638	354	191	141	116	71

A_2 (Cold temperature)	1450	1127	918	689	636	492
S.Em. ±	**58.37**	**43.49**	**48.40**	**29.06**	**45.51**	**24.05**
C. D. @ 1%	**176.50**	**131.52**	**146.34**	**87.86**	**137.62**	**72.72**
Factor II : Relative Humidity (B)						
B_1 (at 0 % RH)	790	199	000	000	000	000
B_2 (at 45-50% RH)	786	514	362	189	111	39
B_3 (at 90-95 % RH)	389	207	105	000	000	000
B_4(at ambient RH)	2210	2044	1751	1484	1393	1089
S.Em. ±	**82.55**	**61.51**	**68.44**	**41.09**	**64.36**	**34.01**
C. D. @ 1%	**249.61**	**186.00**	**206.95**	**124.25**	**194.62**	**102.84**
Interaction (A × B)						
A_1B_1	900	133	000	000	000	000
A_1B_2	522	332	160	160	86	000
A_1B_3	83	-	-	-	-	-
A_1B_4	1045	951	603	429	378	288
A_2B_1	680	264	000	000	000	000
A_2B_2	1050	695	564	219	136	78
A_2B_3	695	413	210	000	000	000
A_2B_4	3375	3136	2900	2539	2407	1891
S.Em. ±	**116.74**	**86.99**	**96.79**	**58.11**	**91.02**	**48.10**
C. D. @ 1%	**352.99**	**263.09**	**292.68**	**175.72**	**275.23**	**145.43**

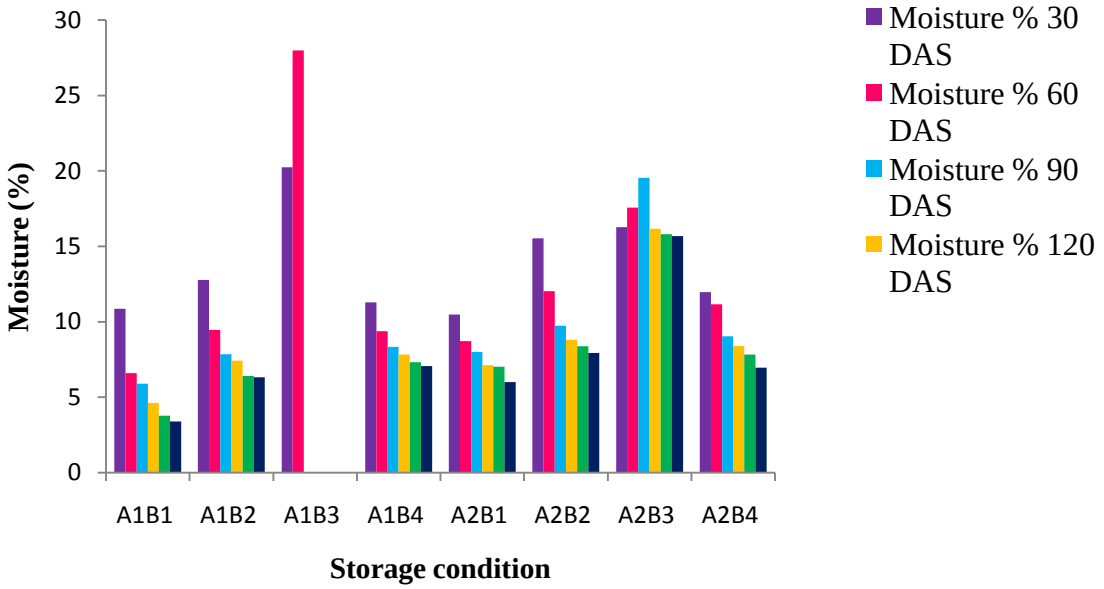

Fig.1 Trend of moisture content under storage temperature and relative humidity regime for six months storage in *Impatiens talbotii*

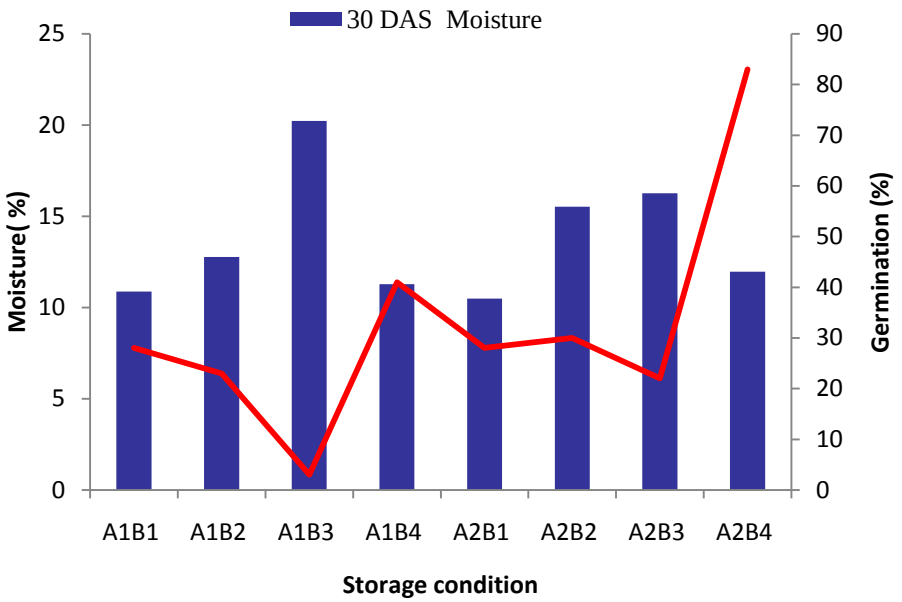

Fig.2 Relationship between moisture per cent and germination per cent after 30 days of storage in *I.talbotii*

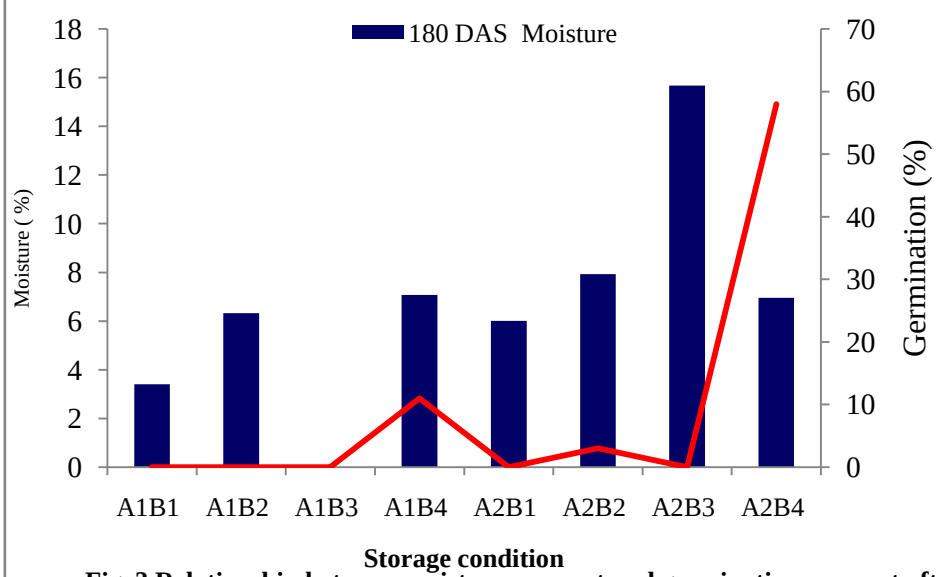

Fig. 3 Relationship between moisture per cent and germination per cent after 180 days of storage in *Impatiens talbotii*

CONCLUSION

Moisture content of the seed was greatly influenced by the storage condition during the storage mainly, temperature and relative humidity. Seeds stored at cold temperature retained the higher moisture content throughout storage period (13.57 % and 9.14 % moisture content at the end of 30 and 180 days after storage respectively) than the seeds stored at cold temperature. Seeds stored at 90-95%t RH under cold temperature retained significantly high moisture content throughout the storage period (15 % moisture content at the end of the 180 days of storage) over the other RH levels. There was significant difference in germination attributes due to the storage condition. Low temperature recorded maximum germination

percent high rate of germination, higher seedling length and seedling vigour index after 30 days of storage. Seeds stored at ambient temperature under cold storage exhibited high germination (83%) and seed quality attributes over the other storage condition after 30 days of storage and reduced to 58 per cent at the end of 180 days after storage. In general, there was significant and gradual decrease in seed germination and quality was observed in all the storage condition with high RH level. The results of present investigation may be helpful in seed germplasm conservation of rare and endangered *I.talbotii* for longer period.

REFERENCES

Anonymous (1996). International Rules for Seed Testing. *Seed Sci. and Tech.,* (Supplement) : 1-335.

Bhardwaj, R., Sood, M. and Thakur, U. (2014). Effect of storage temperature and period on seed germination of Rheum australe D Don: an endangered medicinal herb of high altitude Himalaya. *Int. J. Farm Sci*., 4(2):139-147.

Bhaskar, V. (2006). *Impatiens clavata* Bhaskar sp. nov. – A new scapigerous balsam (Balsaminaceae) from Bisle Ghat, Wester Ghats, South India. *Curr. Sci*., 91(9): 1138-1140

Ganesh, N. M. B., Jyosna, R. N. D., Ravikumar, K. and Rao, R. N. (2007). *Imapties mysoresnis* Heyne ex Roth. (Balasaminacea) a little known endemic from Karnataka. *J. Phytotax*., 7(3):83-88.

Guedes, R. S., Alves, E. U., Melo, P. A. F. R., Moura, S. S. S. and Silva, R. S. (2012). Storage of *Tabubia caraiba* Mart. Bureau seeds in different packaging and temperatures. *Revista Brasileira de Sementes*, 34(3):92-99.

Holmes, G. O. and Buszewicz, G. (1958). The storage of seed of temperate forest tree species. *Forestry Abstract*, 19(4): 313-322.

Jyosna, R. N. D., Joseph, L. and Janarthanam, M. K. (2009). A new species of epiphytic *Impatiens* (Balsaminaceae) from the Western Ghats, India. *Taiwania*., 54(2):149-151.

Pradhan, K. B. and Badola, K. H. (2012). Effects of storage conditions and storage periods on seed germination in eleven population of *Swertia chirayita:* a critically endangered medicinal herb in Himalaya. *Scientific World Journal*, 5(2):125-132.

Singh, B. G., Mahadevan, N. P., Santhi, K., Manimuthu, L. and Geetha, S. (1997). Effect of moisture content on the viability and storability of *Azadirachta indica* seeds. *Ind. For*., 123(7):631-636.

Vivekananthan, K., Rathakrishnan, N. C., Swaminathan, M. S. and Ghara, L. K. (1997). Balsaminaceae. In: Flora of India. Ed. Hajra, P.K., Nair, V.J. and Daniel, P., *Botanical Survey of India, Calcutta*. 4. pp. 95-229.

RESEARCH ARTICLE

EVALUATION OF GENETIC VARIABILITY IN BLACK GRAM (*VIGNA MUNGO* L. HEPPER) GERMPLASM

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Abstract: The present investigation was conducted during kharif-2017-18 in the Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University ofAgriculture, Technology and Sciences, Allahabad to examine 39 Black Gram genotypesalong with 2check (T9 and AZAD.1) to evaluate Genetic variability, correlation for yield in black gram. The experiment was laid out in an in Randomize Block Design replicate thrice. Analysis of variance showed highly significant differences among 39 genotypes of black gram for 13 characters studied. Moderate genotypic coefficient of variation and phenotypic coefficient of variation was recorded for number of clusters per plant, primary branches per plant and seed yield per plant. All characters showed High broad-sense heritability and high genetic advance as percent of mean was recorded for seed yield per plant and plant height. Biological yield, harvest index, seed yield per plant, exhibited high GCV, PCV and genetic parameters revealed that heritability (broadsense) and genetic advance as % of mean values were high for seed yield per plant indicating that selection would be fruitful for improvement of these traits.

Keywords: Black gram, Correlation, Genetic variability, Genotype

INTRODUCTION

Among pulses, Black Gram (*Vigna mungo* L.) is an important short duration crop widely cultivated in India which gives us an excellent source of easily digestible good quality protein and ability to restore the fertility of soil through symbiotic nitrogen fixation. The major constraints in achieving higher yield of this crop are lack of genetic variability, poor harvest index, suitable varieties and genotypes with adaptation to local condition. Yield is considered as an end product of a set of plant processes which are related to each other. It is very complextrait which controlled by poly genes and interlinked with other yield components, hence it is very difficult often to improve yield directly. It can be achieved by improving closely related traits. The systematic collection of black gram has displayed inadequate variability for biotic and abiotic genes. It is possible that genes for high productivity could have been lost due to overriding role of natural selection (Roopalakshmi *et al*., 2003) and the genetic base of the present day collection remains poor (Delannay *et al*., 1983) due to lac of variability owing to its autogamaous nature. The creation of variability is difficult through hybridization due to its high self-pollination and flower droop (Deepalakshmi and Anandakumar, 2004) Besides the major constrains in achieving higher yield of blackgram is absence of suitable ideotypes for different cropping system, poor harvest index and susceptibility to disease (Souframanien and Gopalakrishnan, 2004) . In order to improve yield and other polygenetic characters, mutation breeding can be effectively utilized (Deepalakshmi and Anandakumat, 2004). Therefore genetic variability is the basic requirement for making progress in crop breeding (Appalaswamy and Reddy, 2004). In India black gram is grown both in winter and summer as monocrop and inter crop, respectively. That is why no single plant type is appropriate for all production system. So the variability among the existing germplasm or the accessions is the primary need to develop appropriate plant type for specific production system. Black gram originated in India where it has been in cultivation from ancient times and is one of the most highly prized pulses of India. A successful breeding programme in black gram would need information on the nature and degree of genetic divergence in the available stock for choosing the right parents for further improvement (Falconer, 1981). Grain yield is complex character, which depends on its main components viz; number of pod per plant, pod length, number of seed per pod and 100 seed weight. These components are further dependent for their expression on several morphological and developmental traits, which are interrelated with each other and therefore, the parent selected for the breeding programmes aimed at increased seed yield should possess wide range of genetic variation for the above said morphological and developmental characters. Besides, it could be of interest to know the magnitude of variation due to heritable component, which in turn would be a guide for selection for the improvement of a population. In other words, for the improvement in any crop species, the knowledge of genetic variability for characters of economic importance and their heritability and genetic advance is of utmost importance in planning future breeding programme (Singh *et al.*, 2007). Therefore, the present investigation was carried out on set of 39 genetically

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diverse Black gram (*Vignamungo* L. Hepper) genotypes with the aim of assessing the genetic advance, heritability (Broad sense) and mean and component characters.

MATERIALS AND METHODS

The experimental material for the present investigation consisted of 39 genotypes obtained from the Department of Genetic and Plant Breeding, SHUATS, Allahabad. The present experiment was conducted in randomized block design at Field Experimentation Centre, Department of Genetics and Plant Breeding, Allahabad during *kharif*, 2017. The Allahabad district is situated at 25.280 N and 81.540 E with an altitude of 98m above sea level. Allahabad is located in the south-eastern of Uttar Pradesh and has a sub-tropical climate with extremes of summer and winter. Recommended cultural practices were followed to raise healthy crop. Five competitive plants from each genotype were randomly selected for recording observations on thirteen characters, viz., Days to 50 per cent flowering, Days to 50 per cent pod setting, Plant height (cm), Number of primary branches per plant, number of clusters per plant, number of pods per plant, Pod length (cm), days to maturity, Number of seeds per pod, Biological yield per plant (g), Harvest index (%), Seed index (g) and Seed yield per plant (g). Analysis of variance was carried out as per standard procedure (Fisher, 1938). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) (Burton, 1952), heritability (Burton and Devane, 1953), genetic advance (Johnson *et al*., 1955), were estimated.

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance revealed significant differences for all the characters indicating sufficient variability among the genotypes. The perusal of data revealed that the mean sum of squares due to genotypes showed highly significant for all the 13 quantitative characters. Significant genetic variation in various component characters exhibited by the genotypes indicated these characters might be effective. The results from analysis of variance among 39 blackgram[*Vignamungo*(L.) Hepper] genotypes for 13 quantitative characters are presented in Table.1. The analysis of variance revealed the existence of significant differences among the genotypes for all the traits. Hence, the data on all the 13 traits which showed significant differences among the entries were subjected to further statistical analysis. The quantitative characters are governed by manygenes and are more influenced by environment. Thephenotype observed is not transmitted entirely to nextgeneration. Therefore, it is necessary to know theproportion of observed variability that is heritable.Heritability estimates provides the assessment ofamount of transmissible genetic variability to totalvariability, happens to be the most important basiccomponent that determines the genetic improvementor response to selection. However, the degree ofimprovement attained through selection is not onlydependent on heritability but also on the amount ofgenetic variation present in the breeding populationand the extent of selection pressure applied by the breeder (Panigrahi*et al*. 2014).

Mean and Range of genotypes

The mean value, range, parental mean, hybrid mean, check mean, grand mean, standard error of mean and critical difference (CD) of parents and hybrids for all 13 characters which revealed a wide range of variation for all traits.

Days to 50% Flowering

In case of parents, the mean recorded for days to 50% flowering was 40.61. The highest mean, 49.66 was exhibited by AZAD-1. The lowest mean, 38.33 was showed by KPU-63-189. In case of crosses, the mean recorded for days to 50% flowering was 38.48. The highest mean, 49.00 was exhibited by cross SHUATS URD 54 (PU-31×KU-13-01). The lowest mean, 34.66 was showed by cross SHUATS URD 68 (MASH-338×IU-02-1-3).

Days to 50% pod setting

In case of parents, the mean recorded for days to 50% pod setting was 51.76. The highest mean, 57.33 was exhibited by AZAD-1. The lowest mean, 47.00 was showed by KPU-63-189.In case of crosses, the mean recorded for days to 50% pod setting was 48.25. The highest mean, 56.33 was exhibited by cross SHUATS URD 64 (MASH-338×T4). The lowest mean, 40.00 was showed by cross SHUATS URD 68 (MASH-338×IU-02-1-3).

Plant height (cm)

The population means of parents for the character, plant height was recorded as 55.60 cm, which ranged from 47.6 to 69.2 for parents PU-38 and T4 respectively. The parent T4 was found to be statistically significant with respect to other twelve parents.The population mean of crosses for plant height was recorded as 62.19 cm, which ranged from 43.7 to 83.6 for SHUATS URD 68 (MASH-338×IU-02-1-3) and SHUATS URD 71 (PU-11-14×UTTARA) respectively.

No. of Primary branches per plant

Among the parents, the mean performance for number of primary branches per plant was 2.41. The highest mean, 2.93 was calculated for parent LBG-648 and lowest mean, 1.86 was calculated for the parent PU-31.In case of crosses, mean performance for number of primary branches per plant was 3.40. The highest mean, 4.26 was calculated for the cross SHUATS URD 70 (PU-31×MU-06) and the lowest mean 2.33 for the cross, SHUATS URD 60 (PU-38×LBG-648).

Number of clusters per plant

Among the parents, the mean performance for number of clusters per plant was 9.64. The number of clusters per plant ranged from 7.60 for the parent VALLABH URD to 12.73 for the parent T4.In case of crosses, the mean performance for number of clusters per plant was 8.24. The highest mean, 12.33 was calculated for the cross SHUATS URD 55 (PU-31×KPU-13-192) and lowest mean, 5.00 was exhibited by the cross SHUATS URD 61 (PU-38× KPU-13-192).

Number of pods per plant

In case of parents, the mean performance for number of pods per plant was 24.80. The highest mean, 36.40 was showed by the parent AZAD-1 and lowest mean, 19.93 was exhibited by parent KU-96-7. In case of crosses, the mean performance for number of pods per plant was 26.79. The highest mean, 75.66 was calculated for the cross SHUATS URD 58 (PU-31×MU-06) and lowest mean, 14.40 was exhibited by the cross SHUATS URD 61 (PU-38× KPU-13-192).

Number of seeds per pod:

In case of parents, the mean recorded for number of seeds per pod was 6.55. The highest mean, 7.00 recorded for the parent PU-38 and lowest mean, 5.80 was exhibited by parent LBG-648.In case of crosses, the mean recorded for number of seeds per pod was 6.38. The highest mean, 7.00 was calculated for cross SHUATS URD 56 (PU-38×KPU-63-189) and SHUATS URD 63 (MASH 338×PU-38) and lowest mean, 5.33 was exhibited by cross SHUATS URD 57(PU-31×KU-96-7).

Pod length (cm):

In case of parents, the mean performance for pod length was 3.98. The highest mean, 4.36 was showed by the parent KPU-13-192 and lowest mean, 3.53 was exhibited by parent T4. In case of crosses, the mean recorded for pod length was 4.21. The highest mean, 4.80 was calculated for the cross SHUATS URD 65 (MASH 338 × VBG-11-14) and lowest mean, 3.73 was exhibited by the cross SHUATS URD 68 (MASH 338 ×IU-02-1-3).

Days to maturity:

In case of parents, the mean recorded for days to maturity was 62.54. The highest mean, 75.66 was recorded for the parent LBG-648 and lowest mean, 62.33 was showed by KU-13-01. In case of crosses, the mean recorded for days to maturity was 68.60. The highest mean, 75.33 was showed by the cross SHUATS URD 64 (MASH 338×T4) and lowest mean, 61.00 was recorded for the cross SHUATS URD 70 (PU-11-14×MU-06).

100 seed weight (g)

In case of parents, the mean recorded for seed index (100 seedweight) was 3.98. The highest mean, 5.71 was exhibited by the parent LBG-648 and lowest mean, 3.35 was showed by the T9.In case of crosses, the mean recorded for seed index was 3.79. The highest mean, 4.25 was showed by cross SHUATS URD 54 (PU-31×KU-13-01) and lowest mean, 2.86 was showed by the cross SHUATS URD 111- (PU-38×KPU-13-192).

Biological yield per plant (g)

In case of parents, the mean recorded forBiological yield per plant was 15.76. The highest mean, 19.53 was exhibited by the parent VBG-11-14 and lowest mean, 12.17 was showed by the LBG-648.In case of crosses, the mean recorded for Biological yield per plant was 19.94. The highest mean, 32.66 was showed by cross SHUATS URD 71 (PU-11-14×UTTARA) and lowest mean, 10.41 was showed by the cross SHUATS URD 70 (PU-11-14×MU-06).

Harvest index (%)

In case of parents, the mean recorded forharvest indexwas 33.34. The highest mean, 46.61 was exhibited by the parent IU-02-1-3 and lowest mean, 24.70 was showed by the KPU-13-192.In case of crosses, the mean recorded for harvest index was 38.26. The highest mean, 78.25 was showed by cross SHUATS URD 69 (PU-11-14×KU-13-01) and lowest mean, 14.31 was showed by the cross SHUATS URD 71 (PU-11-14×UTTARA).

Seed yield per plant (g)

In case of parents, the mean recorded for seed yield per plant was 5.17g. The highest mean, 8.78g was exhibited by the parent PU-11-14 and lowest mean, 3.06g was showed by the parent LBG-648.In case of crosses, the mean recorded for seed yield per plant was 7.05. The highest mean, 10.04 was showed by the cross SHUATS URD 59 (PU-38×T4) and lowest mean, 4.03 was showed by SHUATS URD 69 (PU-11-14×KU-13-01).From the foregoing discussion, it is interesting to note that the best five parents mean performance for seed yield per plant recorded highest for PU-11-14 followed by T4, MASH 338, KPU-63-189 and VBG-11-14. Whereas the best five crosses mean performance for seed yield per plant recorded highest for SHUATS URD 59 (PU-38×T4) followed by SHUATS URD 72 (PU-11-14×PU-38), SHUATS URD 64 (MASH 338×T4), SHUATS URD 58 (PU-31×MU-06) and SHUATS URD 55 (PU-31×KPU-13-192).

Estimation of genetic parameters

One of the important considerations in any crop improvement is the detailed study of genetic variability. Variability is a measure by estimation of mean Genotypic and Phenotypic variation, Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), heritability (h^2) in the broad sense, genetic advance and genetic advance as percent of the mean. This would be of great help to the breeder in evolving a selection programme for genetic improvement of crop plant.The estimates of mean Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), heritability (h2) in broad sense, Genetic advance and Genetic advance as percent of mean for all the thirteen characters studied have been boxed in Table and fig explained here as under.

Phenotypic and genotypic coefficient of variation:
To evaluate the genetic variability statistics has offered various analytical techniques. A genotypic and phenotypic coefficient of variation is one of them which offer to estimate the extent of variability in material under investigation.The estimation of genotypic and phenotypic components of variation gives us an idea of relative extent of heritable and non heritable variation. Thus, the components of variation such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated. The phenotypic coefficients of variation were marginally higher than the corresponding genotypic coefficient of variation. Verma and Katna (1998) demonstrated the influence of environment on the expression of the character under study.Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are categorized as low (less than 10%), Moderate (10-20%) and high (more than 20%) as suggested by Sivasubramanian and Madhavamenon (1973). The estimated GCV and PCV helped in getting a clear understanding of the variability present among the various genotypes.

Genotypic coefficient of variation
The GCV was high for biological yield (27.20%) followed by harvest index (26.38%), seed yield per plant (25.18%), primary branches per plant (22.33%), clusters per plant (20.21%).The GCV was moderate for pods per plant (19.02%), plant height (15.41%) and seed index (12.22%).The GCV was low for rest of the characters like days to 50% flowering (7.40%) days to 50% pod setting (7.68%), pod length (6.83%), days to maturity (4.86%) and seeds per pod (2.77%).

Phenotypic coefficient of variation
The PCV was high for harvest index (29.36%) followed by, biological yield (28.60%), seed yield per plant (26.47%), primary branches per plant (25.74%), clusters per plant (23.84%) and pods per plant (22.10%).The PCV was moderate for plant height (16.28%) followed by, seed index (15.73%), pod length (10.25%).The PCV was low for rest of the characters like 50% pod setting (9.45%), days to 50% flowering (7.84%), days to maturity (7.04%) and seeds per pod (4.94%). In present study genotypic coefficient of variation (GCV) for biological yield per plant, harvest index, seed yield per plant and primary branches per plant was noted high which suggest good scope for yield improvement through direct selection. However, pods per plant, plant height and seed index has considerable genetic variability which can be further exploited for yield improvement. Magnitude of phenotypic coefficient of variation (PCV) for harvest index, biological yield, seed yield per plant, primary branches per plant was noted high and indicating the influence of environmental factors on seed yield and its component traits. Hence estimation of GCV will be more reliable.

Heritability and genetic advance
Heritablilty governs the resemblance between parents and their progenies whereas the genetic advance provides the knowledge about expected gain for a particular character after selection. Heritability suggests the relative role of genetic factors in expression of phenotypes and also acts as an index of transmissibility of a particular trait to its offsprings. However, the knowledge of heritability alone does not help in formulating concrete breeding programme, genetic advance along with heritability helps to ascertain the possible genetic control for any particular trait. The nature and extent of the inherent ability of a genotype for a character is an important parameter determining the extent of improvement of any crop species. Heritability and genetic advance are the important genetic parameters for selecting a genotype that permit greater effectiveness of selection by separating out environmental influence from total variability.

Heritability estimates along with genetic advance are normally more useful in predicting the gain under selection than that of heritability alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johnson *et al*. 1955). An attempt has been made in the present investigation to estimate heritability in broad sense and categorized as low (<50%), moderate (50-70%) and high (>70%) as suggested by Robinson (1966).

In present investigation high heritability recorded for seed yield per plant (90.00%), primary followed by biological yield per plant (90.00%), plant height (90.00%), harvest index (81.00%), days to 50% pod setting (81.00%), primary branches per plant (75.00%), pods per plant (74.00%), clusters per plant (72.00%), and moderate heritability recorded for days to maturity (67.00%), days to 50% flowering (65.00%), 100-seed weight (60.00%), pod length (44.00%). Kumar and Reddy (1986) also reported low to moderate heritability for 100-seed weight in black gram. It reveals that the character under improvement is highly influenced by environmental effects and genetic improvement through selection would not be rewarded due to masking effect of the environment on the genotypic effect.

The heritability value alone however, provides no indication of the amount of genetic improvement that would result from selection of superior genotypes. The heritability estimates would be reliable if it is limited in a broad sense, additive and non additive gene effects are accompanied with high genetic advance. To facilitate the comparison of progress in various characters of different genotypes genetic advance was calculated as percentage of mean. The magnitude of genetic advance as percentage of mean was categorized as high (> 20%), moderate (20% - 10%) and low (< 10%).

Genetic advance as percentage of mean was observed high in biological yield per plant (53.29%), followed

by seed yield per plant (49.34%), harvest index (48.82%), primary branches per plant (39.90%), clusters per plant (35.90%), pods per plant (33.72%) and plant height (30.04%). It may be concluded that, if the value of genetic advance is high, then the character is governed by additive genes and selection will be rewarding for improvement of such traits.

Genetic advance as percentage mean was recorded moderate for 100 seed weight (19.56%), days to 50% pod setting (14.20%) and days to 50% flowering (12.26%).

However, it was recorded low for the character pod length (9.38%), days to maturity (8.21%) and seeds per pod (1.77%). The above findings were in agreement with the findings of Sharma and Ahmed (1997) and Isaacs *et al*. (2000) who reported moderate genetic advance and Verma and Katna (1998) reported low genetic advance in black gram. Low magnitude of genetic advance reveals the presence of dominance or epistatic variances in the control of aforesaid characters. The low value of genetic advance suggests influence of environment and hence selection for these traits would be worthwhile in later generations because the character is governed by non-additive genes and heterosis breeding may be useful.

High heritability values coupled with high genetic advance as percent of mean showing high to high heritability estimates were observed for the characters *viz.*, biological yield (90.00%,53.29,%), seed yield per plant (90.00%, 49.34%), plant height (90.00%, 30.40%), harvest index (81.00%, 48.82%), days to 50% pod setting (81.00%,14.20%), primary branches per plant (75.00%, 39.90%), pods per plant (74.00%, 33.72%) and clusters per plant (72.00%,35.90%), Characters showing high to low heritability estimates coupled with medium to low genetic advance as percentage of mean indicating greater contribution of dominance and epistatic variance in the expression of the characters. The above findings are of confirming with the Veeraswamy*et al.* (1973), Gout*et al.* (1978), Shrivastava (1985) and Rao (1986) who reported similar findings in black gram.

Table 1. Analysis of variance for 13 quantitative characters in Blackgram

S.N	Character	Replications d.f=2	Treatments d.f=37	Hybrids d.f=21	Parents d.f=13	Hybrids vs.Parents	Checks	Checks vs.Hybrids	Checks vs.Parents	Error	Total
1.	Days to 50% Flowering	6.16	30.95**	19.07**	10.08*	227.05**	20.16*	504.37**	240.00**	4.76	13.37
2.	Days to 50% Pods Setting	12.79*	48.00**	44.71**	16.93**	374.24*	0.66	431.30**	142.37**	3.56	18.28
3.	Days to Maturity	7.41	38.12**	49.03**	30.04*	7.67	0.16	12.83	5.32	5.31	16.09
4.	Plant Height (cm)	25.98	253.50**	341.58**	38.20**	1454.74**	3.37	1198.78**	298.82**	9.47	89.69
5.	Number of Primary branches Per Plant	0.03	1.47**	0.86**	0.21**	30.14**	0.06	1.44**	13.05**	0.14	0.57
6.	Number of Clusters Per Plant	4.10	11.44**	9.50**	7.86**	47.99**	9.62**	90.45**	39.93**	1.32	4.68
7.	Number of Pods Per Plant	14.45	82.54**	87.58**	56.72**	71.34*	25.21	356.51**	500.30**	8.61	32.93
8.	Number of Seeds Per Pod	0.26	0.39	0.47	0.28	0.55	0.24	0.64	0.21	0.30	0.33
9.	Pod Length (cm)	0.14	0.34**	0.28**	0.18**	3.97**	0.00	0.17	1.66**	0.10	0.18
10.	100 Seed Weight (g)	0.28	0.86**	0.29**	1.07**	8.98**	0.04	0.60	4.39**	0.15	0.39
11.	Biological Yield	0.19	81.59**	131.79**	13.68**	259.13**	0.29	7.45	19.61**	2.77	28.54
12.	Harvest Index (%)	11.51	309.74**	456.51**	156.26**	234.67*	4.25	107.96*	12.07	22.86	116.64
13.	Seed Yield Per Plant (g)	0.16	8.74**	9.35**	7.68**	39.08**	0.40	2.31**	0.78	0.29	3.06

** and * Significant at 1% and 5% level of significance respectively

Table 2. Genetic parameters for 13 characters of 39 blackgram genotypes

S. No	Character	Genotypic Variance (Vg)	Phenotypic Variance (Vp)	Genotypic Coefficient of variation (%)	Phenotypic Coefficient of variation (%)	Heritability (h^2) (%) (broad sense)	Genetic advancement (1%)	Genetic advance as per cent of mean (5%)
1.	Days to 50% flowering	8.73	13.50	7.40	9.20	0.65	6.27	4.90
2.	Days to 50% Pods Setting	14.81	18.38	7.68	8.56	0.81	9.12	7.12
3.	Days to maturity	10.94	16.25	4.86	5.92	0.67	7.16	5.59
4.	Plant height	81.34	90.82	15.41	16.28	0.90	22.53	17.58
5.	Number of Primary branches per plant	0.44	0.59	22.33	25.74	0.75	1.53	1.19
6.	Number of Clusters per plant	3.37	4.70	20.21	23.84	0.72	4.11	3.21
7.	Number of Pods per plant	24.64	33.26	19.02	22.10	0.74	11.28	8.80
8.	Number of Seeds per pod	0.03	0.33	2.77	8.93	0.10	0.15	0.11
9.	Pod length	0.08	0.18	6.83	10.25	0.44	0.50	0.39
10.	100-seed weight	0.24	0.39	12.22	15.73	0.60	1.00	0.78
11.	Biological yield	26.27	29.05	27.20	28.60	0.90	12.87	10.04
12.	Harvest index	95.63	118.49	26.38	29.36	0.81	23.19	18.10
13.	Seed yield per plant	2.82	3.11	25.18	26.47	0.90	4.21	3.29

Table 3 (a). Mean performance of 39 genotypes of Blackgram for yield and component characters

S.No	Genotypes	Days to 50% Flowering	Days to 50% Pods Setting	Days to maturity	Plant height	Number of primary branches per plant	Number of Clusters per plant	Number of Pods per plant	Number of Seeds per pod	Pod length	100 seed weight	Biological Yield	Harvest index	Seed yield per plant
1.	PU-31 × LBG-648	40.00	52.33	72.33	61.1	2.60	6.66	31.86	6.20	4.10	3.98	17.03	46.62	7.91
2.	PU-31 × MU-44	39.33	49.33	68.33	60.6	3.60	8.13	31.06	6.33	4.66	3.58	22.11	37.28	8.19
3.	PU-31 × KU-13-01	49.00	51.66	74.00	60.9	3.40	7.60	19.60	6.26	4.06	4.25	20.04	38.14	7.57
4.	PU-31 × KPU-13-192	39.66	50.66	72.00	64.1	3.80	12.33	30.40	6.26	4.33	4.17	27.81	31.19	8.64
5.	PU-31 × KPU-63-189	37.00	51.66	71.33	70.2	3.60	5.86	30.46	7.00	4.36	3.47	19.94	41.07	8.08
6.	PU-31 × KU-96-7	38.66	48.66	68.66	63.4	2.60	9.20	31.46	5.33	3.90	3.85	20.64	35.73	7.28
7.	PU-31 × MU-06	36.00	46.66	64.00	75.4	4.26	10.80	75.66	6.40	4.73	4.04	33.93	26.60	8.99
8.	PU-38 × T4	36.33	47.00	69.00	60.9	3.06	7.00	34.46	6.66	4.63	3.64	18.63	54.20	10.04
9.	PU-38 × LBG-648	39.33	47.33	71.33	39.1	2.33	6.73	25.73	6.80	4.66	3.53	28.53	18.56	5.27
10.	PU-38 × KPU-13-192	36.66	44.66	66.00	65.2	4.20	5.00	14.40	6.66	4.70	2.86	30.17	14.72	4.44
11.	PU-38 × PU-31	39.33	44.00	71.66	68.8	3.80	10.40	30.60	6.53	4.00	3.93	16.66	45.95	7.41
12.	MASH-338 × PU-38	42.33	50.33	70.00	62.4	3.66	7.46	21.20	7.00	4.16	3.67	14.29	54.47	7.78
13.	MASH-338 × T4	43.66	56.33	75.33	68.4	3.06	9.80	28.60	6.00	4.33	4.11	16.88	53.67	9.03

14.	MASH-338 × VBG-11-	44.66	42.33	64.66	48.2	3.93	7.66	28.46	6.40	4.80	3.68	15.59	43.74	6.80
15.	MASH-338 ×	44.40	51.66	71.33	72.6	3.20	8.33	24.33	6.06	4.36	3.49	13.98	39.88	5.53
16.	MASH-338 × PU-11-14	36.66	46.33	62.33	67.8	2.73	10.33	22.27	6.66	3.96	4.01	17.41	46.72	8.10
17.	MASH-338 × IU-02-1-	34.66	42.00	64.66	43.7	3.73	7.80	26.26	6.66	3.76	3.76	14.95	39.83	5.95
18.	PU-11-14 × KU-13-01	35.33	44.00	63.00	69.0	3.40	8.93	17.33	6.00	4.33	3.69	14.26	78.25	4.03
19.	PU-11-14 × MU-06	34.66	43.33	61.00	51.2	2.86	9.33	22.46	5.86	4.00	3.55	10.41	45.77	4.68
20.	PU-11-14 × UTTARA	39.00	48.33	66.00	83.6	3.66	6.86	24.00	6.40	4.33	3.80	32.66	14.31	4.66
21.	PU-11-14 × PU-31	40.66	52.00	68.66	70.5	3.60	8.80	32.66	6.66	4.66	4.01	17.57	51.92	9.10

Table 3 (b). Mean performance of 39 genotypes of Blackgram for yield and component characters

S.No	Genotypes	Days to 50% Flowering	Days to 50% Pods Setting	Days to maturity	Plant height	Number of primary branches per plant	Number of Clusters per plant	Number of Pods per plant	Number of Seeds per pod	Pod length	100 seed weight	Biological Yield	Harvest index	Seed yield per plant
22.	PU-31	42.00	53.00	69.66	64.9	1.86	8.60	20.20	6.46	3.70	3.83	14.82	34.56	5.02
23.	LBG-648	43.66	53.00	75.66	51.8	2.93	12.33	34.40	5.80	3.96	5.71	12.17	25.65	3.06
24.	MU-44	41.66	51.00	64.33	64.4	2.43	11.13	23.66	6.33	4.30	5.33	19.10	36.79	7.02
25.	KU-13-01	39.33	48.00	62.33	65.8	2.26	8.00	21.26	6.66	3.83	3.72	17.10	25.17	4.28
26.	KPU-13-192	38.66	49.33	64.00	60.2	2.06	9.93	23.60	6.33	4.40	3.98	18.52	24.70	4.58
27.	KPU-63-189	38.33	47.00	69.33	51.8	2.26	11.60	29.13	6.66	4.20	4.32	17.85	40.78	7.22
28.	T4	38.66	50.33	64.33	69.2	2.00	12.73	21.60	7.00	3.53	4.27	18.79	43.58	8.17
29.	MU-06	42.33	50.66	67.66	54.0	2.33	8.13	20.80	6.53	3.83	3.90	17.53	27.92	4.88
30.	MASH-338	42.00	53.66	68.66	49.6	2.66	9.33	26.46	6.26	4.10	4.34	18.56	41.84	7.75
31.	PU-38	41.33	54.66	67.33	47.6	2.40	9.86	28.26	7.00	3.86	4.64	17.15	36.14	6.13
32.	VBG-11-14	43.00	54.33	69.33	65.8	2.00	8.26	29.60	6.93	4.00	4.40	19.52	35.97	7.02
33.	Vallabh Urd	40.66	52.00	68.33	62.9	2.53	7.60	20.13	6.33	4.10	3.88	16.11	31.12	5.01
34.	PU-11-14	39.66	51.66	66.66	67.1	2.46	8.66	21.46	6.53	3.53	4.01	18.92	46.50	8.78
35.	IU-02-1-3	40.33	51.66	70.66	59.5	2.40	9.95	27.93	6.33	4.10	4.01	14.46	46.61	6.76
36.	Uttara	42.00	53.66	68.66	67.8	2.46	10.40	27.23	6.66	3.63	5.23	18.47	37.09	6.83
37.	KU-96-7	44.33	55.33	68.33	66.5	2.26	8.06	19.93	6.66	3.86	3.85	14.24	34.59	4.84
38.	T9	46.00	56,66	66.66	46.7	3.86	13.66	32.36	6.53	4.50	3.35	18.78	33.22	6.21
39	AZAD	49.66	57.33	67.00	48.2	3.93	11.13	36.46	6.93	4.50	3.62	19.22	34.90	6.73
	Mean	**39.91**	**50.10**	**68.06**	**58.51**	**2.98**	**9.08**	**26.09**	**6.46**	**4.17**	**3.98**	**18.84**	**37.06**	**6.66**
	C.V.	5.47	3.76	3.38	5.26	12.79	12.65	11.24	8.49	7.63	9.89	8.83	12.89	8.15
	F ratio	6.49	13.45	7.17	26.75	10.13	8.65	9.58	1.32	3.40	5.57	29.43	13.54	29.57
	S.E.	1.26	1.09	1.33	1.77	0.22	0.66	1.69	0.31	0.18	0.22	0.96	2.76	0.31

	C.D. 5%	3.55	3.07	3.74	5.00	0.62	1.87	4.77	-----	0.51	0.64	2.70	7.77	0.88
	C.D. 1%	4.71	4.07	4.97	6.64	0.82	2.48	6.33	-----	0.68	0.85	3.59	10.31	1.17
	Range Lowest	34.66	42.00	61.00	39.13	1.86	5.00	14.40	5.33	3.53	2.86	10.41	14.31	3.06
	Range Highest	49.66	57.33	75.66	83.63	4.26	13.66	36.46	7.00	4.80	5.71	33.93	54.47	10.04

CONCLUSION

It was concluded from the present investigation that among 21 crosses of blackgram on the basis of mean performance and heterosis the crosses PU-38×T4 recorded the high performance for seed yield per plant followed by PU-11-14×PU-31 and MASH-338×T4, PU-31 □ LBG-648, PU-31 □ MU-06, PU-31 □ KPU-13-192 was found to be superior crosses these performed maximum seed yield.Biological yield, harvest index, seed yield per plant, exhibited high GCV, PCV and genetic parameters revealed that heritability (broadsense) and genetic advance as % of mean values were high for seed yield per plant indicating that selection would be fruitful for improvement of these traits.

REFERENCES

Appalaswamy, A. and Reddy. (2004) Genetic divergence and heterosis studies of mungbean (*Vignaradiata* L. Wilczek).*Legume Research*. 21: 115-118.

Burton, G.W.(1952). Quantitative inheritance in grasses Proc. 6th int. Grassland cong.1:227-283.

Burton, G.W., and DeVane, E.M. (1953). Estimating heritability in tall fesses from replicated cloned material. *Journals of Agronomy*. 45(3): 474-481.

Deepalakshmi, A.J. and Anandakumar, C.K.(2004).Creation of genetic variability for different polygenic traits in black gram (Vignamungo (L.)Hepper) through induced mutagenesis. *Legume Research*. 3:188-192.

Delannay, X., Rodgers, D.M. and Plamer, R.G. (1983). Relative genetic contribution among ancestral lines to North America soybean cultivars.*Crop Sci*. 23: 944-949

Falconer, D.S. (1981).Introduction to Quantitative genetics, 3rd ed. Longman, New York. 340

Fisher, R.A. (1938). Statistical tables for biological, agricultural and mendelianinheriatance. France Royal Society of Edinburgh.52:399- 433.

Gout, J. V., Viraktanath, B.C. and Laxmi, P. V. (1978).Variability and correlation studies in black gram (*Phaseolusmungo* L.).*Mysore J. Agric. Sci*., 11 (3): 322-325.

Isaacs, S. M., Jebaraj, S. and Ganesh, S. K. (2000).Estimates of genetic variability and heritability in black gram [*Vignamungo* (L.)Hepper].*Res. on Crops*. 1 (1): 37-39.

Johnson, H.W., Robinson, H.F. and Comstock, R.E.(1955).Genotypic and Phenotypic Correlations in Soybean and their implications in selection.*Agronomy*.47:477-438.

Kumar, M. H. and Reddy, P. N. (1986).Variability and heritability in F3 progenies of black gram (*Vignamungo* L. Hepper).*J. Res. APAU*. 14: 14-17.

Panigrahi, K.K., Mohanty, A. and Baisakh, B. (2014). Genetic divergence, variability and character association in landraces of blackgram (*Vignamungo* L. Hepper) from Odisha*J.Crop and Weed*. 10(2): 155-165.

Rao, S. S. (1986). Genetic analysis of yield and its components in black gram (*Vignamungo* (L.)Hepper) Ph.D. Thesis, Jawaharlal Nehru KrishiVishwavidyalaya, Jabalpur.

Robinson, H.F. (1966). Quantitative genetics in relation to breeding on the centennial of mendelism. *Indian Journal of Genetics*. 26: 171 - 187.

Roopalakshmi, K., Kajjidoni, S.T. and Salimath, S.M.(2003). Effect of irradication and matting schemes on native of association of seed yield and its components in black gram.*Legume Research*.26(4):288-291.

Sharma, Debojit and Ahmad, N.U.(1997). Genetics and combining ability studies for yield and its components in black gram [*Vignamungo* (L.)Hepper].*J. Agric. Sci. Soc. North East India*. 10 (1): 19-24.

Shrivastava, D. K. (1985).Genetic analysis of yield and its components in urd (*Vignamungo* L. Hepper). M. Sc. Thesis, Jawaharlal Nehru KrishiVishwavidyalaya, Jabalpur.

Singh, I. P., Singh, S.K., and Singh, K. P. (2007) Genetic variation, character association and path analysis between grain yield and its component in black gram [*Vignamungo* (L.) Hepper].*Progressive Agriculture*.7(1/2):113-115.

Sivasubramanian, S. and Madhavamenon, P. (1978).Genotypic and phenotypic variability in rice.*Madras Agric. J*. 60: 1093-1096.

Souframanien, J. and Goplalakrishnan, T. (2004).A comparative analysis of genetic diversity of black gram genotype uing RAPD and ISSR markers.*The Applied Genetics*.109:1687-1693.

Veeraswamy, R., Paloniswamy, G. A. and Swamy, R. (1973). Yield attributes and heritability in some varieties of black gram (*Phaseolusmungo*L.Hepper). *Madras Agric. J*., 60: 183- 185.

Verma, S. and Katna, G. (1998). Variability studies in urdbean for intercrop and monocrop conditions. *Indian J. Pulses Res*., 11 (1): 33-37.

RESEARCH ARTICLE

INFLUENCE OF STORAGE MEDIA AND CONTAINERS ON SEED GERMINATION AND SEEDLING QUALITY IN *GARCINIA GUMMI-GUTTA* L.

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Abstract: A laboratory study was undertaken at Department of Forest Biology and Tree Improvement, College of Forestry, Sirsi, University of Agriculture Sciences, Dharwad during 2016-17 to find out the suitable media and containers for storage of ***Garcinia gummi-gutta*** seeds. Uniform sized and healthy seeds were stored in different medium and containers under ambient temperatures at laboratory using completely randomized design. Seed without any medium was treated as control. In treatment T_2 dried seeds were mixed with ash at the rate of 1:2 ratios. One kg of dried seed packed in the perforated gunny bag was considered as treatment (T_3). In treatment T_4 and T_5 dried seeds were mixed with sawdust and sand at the rate of 1:2 ratios respectively. One kg of dried seed packed in the pet jar was T_6 treatment. At interval of every 30 days, 100 seeds from each treatment in four replications were taken up from stored seed lot till six months of storage for germination studies. Seeds were sown at monthly interval up to six months.During six months of storage, the fresh seeds recorded maximum germination (18.75 per cent) and decline in germination was noticed with advancement in the storage period. Among the storage media and container, seed stored in pet jar recorded maximum germination per cent (14.50 per cent, 11.50 per cent, 9 per cent and 4.75 per cent) in third, fourth, fifth and sixth months of storage respectively. Germination per cent in control is negligible after 3 months of storage. Maximum mean daily germination and peak value was in seed stored in pet jar and the lowest in control and sand media at end of six months of storage. The mean daily seed germination, peak value and germination value were exhibiting the negative trend as advancement in seed storage period. The seedling length was non-significantly influenced by all storage media in first and third months of storage. Higher seedling length (11.70 cm, 12.98 cm) was recorded in pet jar at fourth and fifth months of storage respectively. Seedling vigour index was non-significant at first month of storage of seed at different medium. At the end of second month of storage, the maximum seedling vigour index (194) was recorded in saw dust.

Keywords: Pet jar, Saw dust, Sand germination, Vigour

INTRODUCTION

Majority of economically important trees species found in tropics are recalcitrant seeds, storage of which is one of the major problems. *Garcinia gummi-gutta* is one of the most economically recalcitrant species which lose its viability within few days under natural conditions, when the seed moisture content reduces below a high critical value. Most recalcitrant seeds are non-dormant or viviparous, because germination is initiated around shedding from the maternal plant (Farrant *et al.*, 1988; Berjak and Pammenter, 1996). There is a major hypothesis to explain the rapid germination of recalcitrant seeds. Seeds pass from a development to germination mode and the seedlings become established more rapidly when environmental conditions are continuously favorable (e.g. in moist tropical forests; Berjak and Pammenter, 2000). Storage environment is obviously very important in extending the life of seeds. The ideal metabolic rate in storage will conserve as much of the stored food reserves in the seeds as possible, yet operate at a level that maintains the integrity of the embryos. Although, seed are propagated virtually no systematic work has been done either for their multiplication or to know the causes for their dormancy and poor germination in *Garcinia gummi-gutta*. As the germination of this tree is very poor and late, there is a need to study these problems especially on germination, dormancy, seed moisture content and storage behavior etc. in order to uplift or enhance the quality for better and quick germination.

A major problem in using the seeds of many trees in reforestation programmes is the short storage life of their seeds. Sometimes it is not even possible to store the seeds from harvest until the next sowing season. Indeed, for some species it is hardly possible to maintain viability during collecting and transportation. Improved methods for short- or medium-term storage and for handling are required to enable the use of these species in reforestation programmes. Long-term storage for genetic conservation presents even greater problems.

The demand for nursery grown seedlings has increased manifold for planting under social forestry programme and massive afforestation programme taken up by the government agencies. Lack of standard nursery techniques hinders such attempts. Even poor natural regeneration, low rate of seed germination makes the situation more badly in case of certain species. Seed moisture content and storage of seeds play an important role to produce healthy and vigorous seedling at nursery.

Collection and storage of recalcitrant seeds is only first step in ex-situ conservation. Saving the seeds for

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future, forms the most important and crucial aspect of conservation (Ellis *et al*., 1990). Due to their poor storability, collection and cleaning, proper storage of recalcitrant seeds becomes essential. Seeds upon harvest from trees must be processed on site. The decision to extract the seeds from the fruit at a central seed processing depot or close to the site or soon after must be made in the light of local conditions. The longevity of recalcitrant seeds is very short: it varies from a few days to a few months or a year under proper storage conditions. Therefore recalcitrant seeds are to be sown immediately after seed collection. Because of their short longevity, viability which varies from few days, they may be kept within the fruit itself for some time. But due to high moisture content it may enhance the pathogen entry and create germination loss. Almost all the researches had the same opinion regarding the storing of seeds in tin containers which resulted in poor storage due to improper ventilation, accumulation of carbon-dioxide and increased metabolic heat. Storage in polybags was considered as most favourable if seeds were placed in a moist media (Srimathi, 1997)

MATERIAL AND METHODS

A comprehensive laboratory study entitled "**Influence of storage media and containers on seed germination and seedling quality in *Garcinia gummi-gutta* L.**" was undertaken at Department of Forest Biology and Tree Improvement, College of Forestry, University of Agriculture Sciences, Dharwad during 2016-17.

Plate 4: Seed storage in different media and containers

To find out the suitable media and containers for storability of seeds, uniform sized and healthy seeds were stored in different medium and containers under ambient temperatures at laboratory using completely randomized design. Seed without any medium was treated as control. In treatment T_2 dried seeds were mixed with ash at the rate of 1:2 ratios. One kg of dried seed packed in the perforated gunny bag was considered as treatment (T_3). In treatment T_4 and T_5 dried seeds were mixed with sawdust and sand at the rate of 1:2 ratios respectively. One kg of dried seed packed in the pet jar was T_6 treatment. At interval of every 30 days, 100 seeds from each treatment in four replications were taken up from stored seed lot till six month for germination studies. Seeds were sown at monthly interval up to six months. Seeds sown were considered germinated when plumule emerged above the soil. Daily observations were taken till 150 days from the date of sowing. The observations on seed germination, mean daily germination, peak value, germination value, shoot length, root length, seedling length, seedling dry weight and vigour index were recorded.

RESULTS AND DISCUSSION

Influence of storage media and period on germination percentage of *Garcinia gummi-gutta* seeds was studied. The seeds were evaluated initially and at monthly intervals upto 6 months for seed quality parameters. The study revealed highly significant treatment variation for all the seed and seedling quality characters. At the first month of the storage the maximum germination was observed in ash treatment (18.75 per cent) and minimum in control (15.5 per cent). At the second month of the storage the maximum germination (16.75 per cent) was observed in saw dust treatment and minimum (11.25 per cent) in control and gunny bag. After the end of third month of storage the maximum germination (14.50 per cent) was recorded in pet jar and minimum (5.50 per cent) in control (Table-1 and Fig-2). At the fourth month of storage the maximum germination was recorded in pet jar (11.50 per cent) and minimum at control (0.75 per cent), at the fifth month of storage of seed the maximum germination (9 per cent) in pet jar and minimum (5.25 per cent) in sand were observed and at the end of sixth month storage the maximum germination (4.75 per cent) in pet jar and minimum in sand (1.50 per cent) were recorded. Germination per cent in control is negligible after 3 months of storage. This might be due to ageing induced seed deterioration during the storage.

Present study revealed that as the period of storage increased germination per cent decreased i.e., viability of seeds decreased. Similar results were recorded by Kumar and Chacko (1999) in seeds of *Bhesa indica*. Gouda *et al.* (2006) reported that fresh seeds of *Garcinia indica* stored in trays containing sand recorded 77.66 per cent germination whereas those stored for one month showed 59.33 per cent. Singh *et al*., (2009) reported that average germination in *Celtis australis* was 42.6 per cent in freshly collected seeds which decreased to 22.4 per cent after 18 month of storage at ambient room temperature.

The mean daily germination and peak value was also significantly influenced by all the storage media treatments at different storage period. Highest mean daily germination (0.13) was recorded in both pet jar and ash and highest peak value (0.13) was recorded in pet jar at first month of storage (Table-2& 3). Lowest mean daily germination and peak value was 0.10 and 0.11 respectively in control at first month of storage. At the second month of storage the maximum mean daily germination (0.11) and peak value (0.20) was recorded in saw dust treatment and lowest mean daily germination (0.07) and peak value (0.08) was recorded in control. The higher mean daily germination (0.11, 0.08, 0.06 and 0.03) and peak values (0.10, 0.08, 0.06 and 0.03) were obtained in treatment with pet jar at third, fourth, fifth and sixth months of storage respectively. There was an increase in both parameters over other treatments. This may be due to prevention of moisture loss from the seeds.

The germination value was significantly influenced by all storage media and containers treatments only in first month storage of seeds. The highest germination value (0.02) was recorded in ash, saw dust and pet jar treatments and lowest value (0.01) in control, gunny bag and sand treatments at first month of storage. The shoot length was non-significantly influenced by all storage media and containers treatments up to third month. Higher shoot length (3.95 cm, 4.10 cm and 4.48 cm) were obtained in treatment with pet jar at fourth, fifth and sixth months storage respectively. And lowest shoot length (2.25 cm) wad recorded in control at fourth month of storage of seed. The lowest shoot length (3.33cm and 4.08cm) was recorded in sand at fifth and sixth months of storage of seed (Table-4).

The root length was non-significantly influenced by all storage media and containers treatments in first and third months of storage of seed. At second month of storage of seeds, the highest root length (7.13 cm) was recorded in saw dust and minimum (5.70 cm) in control. The root lengths 7.28 cm, 7.58 cm and 8.48 cm were obtained in treatments with pet jar at fourth, fifth and sixth months of storage respectively (Table-5). The minimum root length (4.13 cm) was in control at fourth month of storage of seed. The lowest root length (6.58 cm and 6.73 cm) was recorded in sand at fourth and fifth months of storage of seed.

The seedling length was non- significantly influenced by all storage media and containers in first and third months, however, at end of second month of storage the highest seedling length (11.58

cm) was recorded in saw dust treatment (Table-6). At fourth month of storage the highest seedling length (11.48 cm) was recorded in pet jar and minimum (6.38 cm) in control. Again the highest seedling length (11.70 cm, 12.98 cm) was recorded in pet jar and minimum (9.90 cm and 10.20 cm) in sand treatment at fourth and fifth storage respectively.

The seedling dry weight was non-significantly influenced by all storage media and containers in first and second months of storage of seeds. At third month of storage of seeds, the maximum seedling dry weight (0.33 g) was recorded in saw dust treatment and minimum (0.27 g) in control. The maximum seedling dry weight (0.31 g, 0.33g and 0.37 g) was recorded in pet jar at fourth, fifth and sixth months of storage of seeds respectively (Table-7).

Seedling vigour index was non-significant at first and second months of storage of seed at different medium and containers (Table-8 and Fig-2). However, the maximum seedling vigour index (160,132,106 and 62) was recorded in pet jar at third, fourth, fifth and sixth months of storage respectively.

Among the different treatments of media and containers, the present investigation revealed that the pet jar treatment maintained longer viability of seeds with germination percent of 4.75% followed by saw dust (2%) and sand treatment (1.50%) at the end of six months of storage of seeds. It may be due to longer retention of moisture in seeds in case of pet jar treatment. These results are in conformity with that of Chaturvedi and Das (2004), who reported that *Acacia auriculiformis and Acacia nilotica* seeds showed higher germination percentage (more than 60 percent) even after 10-12 months of storage in air tight plastic container in room temperature as compared to other treatments.

Table 1. Influence of storage media and containers on seed germination of *Garcinia gummi-gutta* seeds during storage.

Treatments	Germination percentage					
	Months of storage					
	1	2	3	4	5	6
Control	15.25 (23.10)*	11.25 (19.59)*	5.50 (13.50)*	0.75 (4.31)*	0.00 (0.00)*	0.00 (0.00)*
Ash	18.75 (25.65)*	15.25 (22.98)*	9.25 (17.68)*	3.00 (9.90)*	0.00 (0.00)*	0.00 (0.00)*
Gunny bag	16.50 (23.93)*	11.75 (20.02)*	6.25 (14.45)*	2.00 (8.45)*	0.00 (0.00)*	0.00 (0.00)*
Saw dust	18.00 (25.10)*	16.75 (24.15)*	13.75 (21.76)*	10.00 (19.13)*	8.25 (16.67)*	2.00 (7.99)*
Sand	16.25 (23.76)*	13.50 (21.54)*	10.25 (18.66)*	7.75 (16.16)*	5.25 (13.21)*	1.50 (6.94)*
Pet jar	18.00 (25.09)*	16.50 (23.96)*	14.50 (22.38)*	11.50 (19.80)*	9.00 (17.45)*	4.75 (12.55)*
SEm±	**0.62**	**0.59**	**0.51**	**0.44**	**0.32**	**0.28**
CD@1%	**1.83**	**1.75**	**1.53**	**1.31**	**0.96**	**0.84**

Table 2. Influence of storage media and containers on mean daily germination of *Garcinia gummi-gutta* seeds during storage.

Treatments	Mean daily germination					
	Months of storage					
	1	2	3	4	5	6
Control	0.10	0.07	0.04	0.01	0.00	0.00
Ash	0.13	0.10	0.06	0.02	0.00	0.00
Gunny bag	0.11	0.08	0.04	0.01	0.00	0.00
Saw dust	0.12	0.11	0.09	0.07	0.05	0.01
Sand	0.11	0.09	0.07	0.05	0.03	0.01
Pet jar	0.13	0.11	0.10	0.08	0.06	0.03
SEm±	**0.01**	**0.004**	**0.003**	**0.003**	**0.002**	**0.002**
CD@1%	**0.01**	**0.01**	**0.01**	**0.009**	**0.007**	**0.01**

Table 3. Influence of storage media and containers on peak value of *Garcinia gummi-gutta* seeds during storage.

Treatments	Peak value					
	Months of storage					
	1	2	3	4	5	6
Control	0.10	0.08	0.04	0.01	0.00	0.00

Ash	0.13	0.11	0.07	0.02	0.00	0.00
Gunny bag	0.11	0.08	0.04	0.02	0.00	0.00
Saw dust	0.13	0.12	0.10	0.07	0.06	0.01
Sand	0.12	0.10	0.07	0.05	0.04	0.01
Pet jar	0.13	0.12	0.11	0.08	0.06	0.03
SEm±	**0.004**	**0.004**	**0.004**	**0.003**	**0.002**	**0.002**
CD@1%	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

Table 4. Influence of storage media and containers on germination value of *Garcinia gummi-gutta* seeds during storage.

Treatments	**Germination value**					
	Months of storage					
	1	**2**	**3**	**4**	**5**	**6**
Control	0.01	0.01	0.00	0.00	0.00	0.00
Ash	0.02	0.01	0.00	0.00	0.00	0.00
Gunny bag	0.01	0.01	0.00	0.00	0.00	0.00
Saw dust	0.02	0.01	0.01	0.01	0.00	0.00
Sand	0.01	0.01	0.01	0.00	0.00	0.00
Pet jar	0.02	0.01	0.03	0.01	0.00	0.00
SEm±	**0.001**	**0.001**	**0.001**	**---**	**---**	**---**
CD@1%	**0.003**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 5. Influence of storage media and containers on shoot length of *Garcinia gummi-gutta* seeds during storage.

Treatments	**Shoot length (cm)**					
	Months of storage					
	1	**2**	**3**	**4**	**5**	**6**
Control	4.10	3.54	3.60	2.25	0.00	0.00
Ash	4.23	3.63	3.73	3.58	0.00	0.00
Gunny bag	4.15	3.70	3.63	3.50	0.00	0.00
Saw dust	4.20	4.13	3.95	3.83	4.05	3.53
Sand	4.20	3.80	3.73	3.80	3.33	3.48
Pet jar	4.20	4.10	3.93	3.95	4.08	4.48
SEm±	**0.17**	**0.16**	**0.15**	**0.34**	**0.07**	**0.06**
CD@1%	**NS**	**NS**	**NS**	**1.00**	**0.21**	**0.14**

Table 6. Influence of storage media and containers on root length of *Garcinia gummi-gutta* seeds during storage.

Treatments	**Root length (cm)**					
	Months of storage					
	1	**2**	**3**	**4**	**5**	**6**
Control	7.20	5.70	6.40	4.13	0.00	0.00
Ash	7.53	6.73	6.98	6.38	0.00	0.00
Gunny bag	7.40	5.95	6.53	6.10	0.00	0.00
Saw dust	7.75	7.45	6.98	6.90	7.45	6.78
Sand	7.73	6.63	6.73	6.98	6.58	6.73
Pet jar	8.18	7.13	7.13	7.28	7.58	8.48
SEm±	**0.32**	**0.34**	**0.25**	**0.60**	**0.13**	**0.07**
CD@1%	**NS**	**1.03**	**NS**	**1.78**	**0.38**	**0.21**

Table 7. Influence of storage media and containers on seedling dry weight of *Garcinia gummi-gutta* seeds during storage.

Treatments	**Seedling dry weight (mg)**					
	Months of storage					
	1	**2**	**3**	**4**	**5**	**6**
Control	0.32	0.27	0.27	0.17	0.00	0.00
Ash	0.34	0.29	0.28	0.27	0.00	0.00
Gunny bag	0.32	0.27	0.28	0.26	0.00	0.00

Saw dust	0.33	0.32	0.33	0.30	0.33	0.28
Sand	0.30	0.29	0.28	0.29	0.28	0.27
Pet jar	0.33	0.33	0.31	0.31	0.33	0.37
SEm±	**0.05**	**0.02**	**0.03**	**0.03**	**0.01**	**0.01**
CD@1%	**NS**	**NS**	**0.04**	**0.11**	**0.03**	**0.05**

Table 8. Influence of storage media and containers on seedling vigour index of *Garcinia gummi-gutta* seeds during storage.

Treatments	**Seedling vigour index**					
	Months of storage					
	1	**2**	**3**	**4**	**5**	**6**
Control	186	104	55	6	0	0
Ash	220	160	92	30	0	0
Gunny bag	179	120	61	23	0	0
Saw dust	215	194	151	116	82	21
Sand	195	141	98	84	61	16
Pet jar	196	185	160	132	106	62
SEm±	11.59	10.12	7.69	5.91	4.42	3.45
CD@1%	NS	20.05	22.84	17.55	13.14	10.25

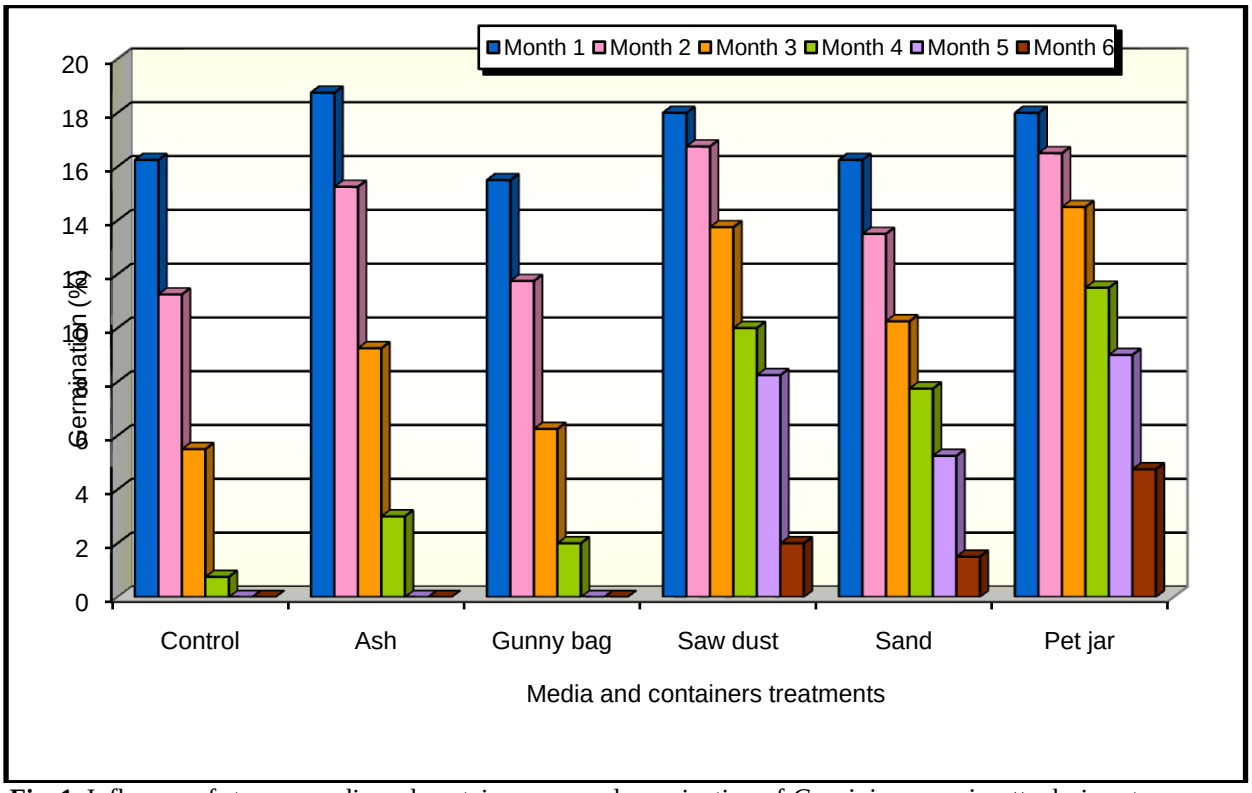

Fig. 1. Influence of storage media and containers on seed germination of *Garcinia gummi-gutta* during storage

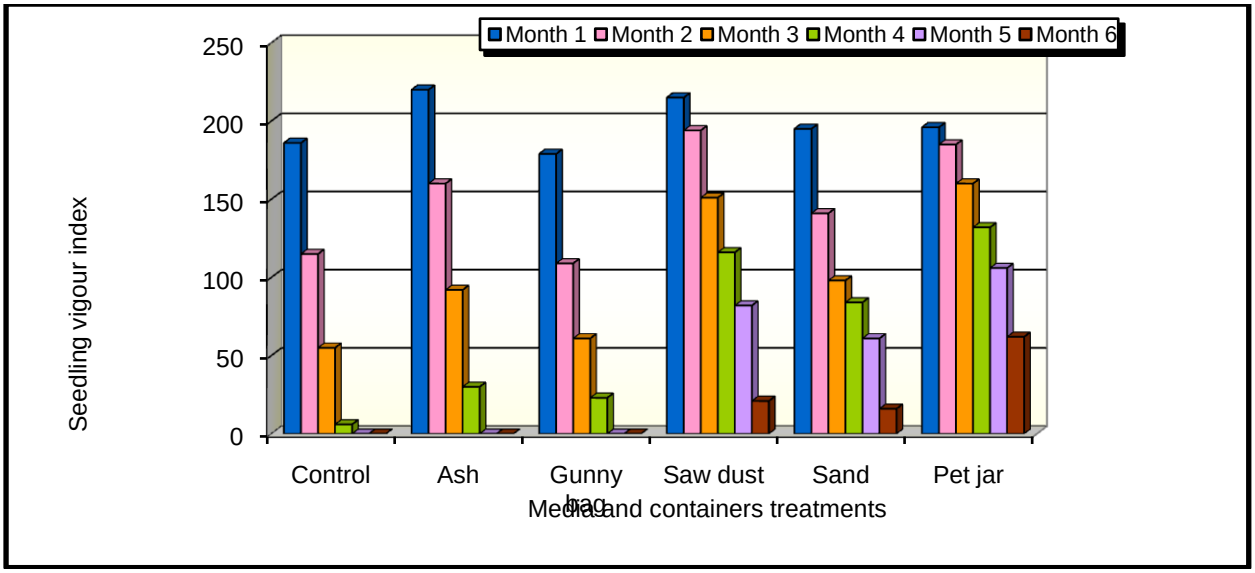

Fig. 2. Influence of storage media and containers on Seedling vigour index of *Garcinia gummi-gutta* during storage

REFERENCES

Berjak, P. and Pammenter, N. W. (1996). Recalcitrant (Desiccation –sensitive) seeds. In- *Innovations in tropical tree seed technology. Proc*. of the IUFRO symposium of the Project Group P.2.04.00 'seed problems', Danida, Denmark. pp. 14-29.

Berjak, P. and Pammenter, N. W. (2000). Orthodox and Recalcitrant Seeds. *Tropical tree seed manual*. USDA Forest Service. pp. 137-147.

Chaturvedi, O. P. and Das, D. K. (2004). Effect of seed drying, storage and pretreatment on the germination and growth of *Acacia auriculiformis* and *Acacia nilotica seedlings. Indian J. For.*, **27**(1):75-81.

Ellis, R. H., Hong, T. D., Robert, E. H. and Tao, K. L. (1990). Low moisture content limits to relations between seed longevity and moisture. *Ann. Bot*., **65**: 493-504.

Farrant, J. M., Pammanter, N. W. and Berjak, P. (1986). The increasing desiccation sensitivity of recalcitrant *Avicennia mariana* seeds with storage time. *Physiol. Pl.*, **67**: 291-298.

Gouda, M., Patil, S. K., Manjunatha, G. O. and Kumar. P. H. (2006). Influence of seed storage and pre-sowing treatments on germination of Kokum *(Garcinia indica). My For.*, **42**(4): 389-396.

Kumar, K. and Chacko, K. C. (1999). Seed characterisation and germination of a shola forest tree: *Bhesa indica* (BEDD). *Annals of For.*, **1**(1): 27-32.

Singh, B., Bhatt, B. P. and Prasad, P. (2009). Effect of storage period on seed germination of *Celtis australis* L. In Central Himalayas India. *Indian J. Agrofor.*, **11**(2): 62-65.

Srimathi, P. (1997). Research focus on seed collection, processing, storage of Amla (*Emblica officianalis* Gaertn.), Jamun (*Syzygium cumnii* Skeels) and ber (*Zizypus mauritiana* Lamk). *Ph.D. Thesis*, Department of Seed Science and Technology, TNAU, Coimbatore.

RESEARCH ARTICLE

SEASONAL INCIDENCE OF BRINJAL FRUIT AND SHOOT BORER, LEUCINODES ORBONALIS GUEN. (LEPIDOPTERA: CRAMBIDAE) UNDER AGRO CLIMATIC CONDITIONS OF ALLAHABAD, INDIA

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Abstract: The seasonal incidence of *Leucinodes orbonalis* Guenee on brinjal was studied at central research farm of the Department of Entomology, SHUATS, Allahabad during Kharif season of 2017. The occurrence of shoot and fruit borer commenced from 39thstandard week on shoot with an average 14.94% of damaged shoot. The borer population increased and gradually reached peak level of 44.67% of damaged shoot at 42nd standard week. Infestation on Fruit commenced from 42rd standard week with an average 45.83% of damaged fruit (Number basis) and 43.43% (Weight basis) during the experiment. The borer population increased and gradually reached peak level of 57.50% of damaged fruit (Number basis) and 55.90% of damaged fruit (weight basis) at 44th standard week and thereafter decline in the trend was noticed till 47th standard week. It was found that the pest build up on shoot (Damage % number basis) was positively correlated with maximum temperature (r = 0.703) and sun shine hours (r = 0.589). However it was negatively correlated with morning relative humidity (r = - 0.730). Whereas percent fruit infestation had positive correlation with maximum temperature (r = 0.604, on number basis and r = 0.597, on weight basis) and sun shine hours (r = 0.586, on number basis and r = 0.595, on weight basis); whereas it had negative correlation with evening relative humidity (r = -0.551, on number basis and r = 0.559, on weight basis). The statistically significant values indicated that occurrence of brinjal shoot and fruit borer was influenced by the prevailing ecological conditions specially Temperature, Relative Humidity and sun shine hours Hence the management of brinjal pest should therefore be promoted from September onwards using an integrated approach.

Keywords: Brinjal, Climatic condition, *Leucinodes orbonalis*, Seasonal incidence

INTRODUCTION

Vegetable cultivation in India is mostly practiced by small and marginal farmers, the socio-economically disadvantaged group. "Vegetable" in general is grown for additional income generation in their backyards or small portion of their scare land holdings, comparatively well-endowed in terms of soil and irrigation. The world wide area, production, and productivity under vegetable crop cultivation in the year 2015 was 58971121 ha, 1159179443 tones and 19.7 million tones ha^{-1}, respectively.

Eggplant, *Solanum melongena* Linnaeus is one of the most important vegetables in South and South-East Asia having hot-wet climate (Hanson *et al.*, 2006). It is grown in almost all states of India, with an area of 679.4 thousand hectares under cultivation and production of 12438.7 thousand metric tons (Anonymous, 2015). The major brinjal growing states in India are Andhra Pradesh, Karnataka, West Bengal, Maharashtra, Orissa, Madhya Pradesh, Bihar, Gujarat and Chhattisgarh.

Uttar Pradesh stands 12th highest brinjal producer in India, with an area of 4.5 thousand hectares under cultivation and production of 151.9 thousand metric tons (Anonymous, 2015). The other major brinjal growing states in India are Andhra Pradesh, Karnataka, West Bengal, Maharashtra, Orissa, Madhya Pradesh, Bihar, Gujarat and Chhattisgarh.

The activity of the pest varies with different agro-climatic situations. Patel *et al.*(1988) observed little difference between maximum and minimum temperature but that high relative humidity and heavy rain are favorable for the outbreak of the pest. Atwal and Verma (1972) reported that development was quicker and the survival rate was greater at higher temperature and humidity, leading to greater abundance during the monsoon period.

It is possible to avoid pest incidence if the congenital weather condition for the insect infestation is fully known in advance. Hence an attempt has been made here to study the impact of weather parameters in relation to seasonal incidence of shoot and fruit borer on brinjal crop under Allahabad Agro climatic conditions.

MATERIALS AND METHODS

The field trials were conducted at SHUATS central field, Department of Entomology, SHUATS, Allahabad. The alluvial soils of this geographical region in general are reported to be flat, well drained and moderately being less in available nitrogen and medium in available phosphorus and potash. The normal pH varies from 7.2 – 8.4. The climate of this region is typically sub-tropical which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to

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46°C – 48°C and seldom falls as low as 4°C – 5°C. The relative humidity ranged between 20 – 94 percent. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

Allahabad is situated at 25.27 north latitude 80.50 east longitude and at an altitude of 98 meter above sea level. The climate is typically semi-arid and subtropical. However experimental field of Department of Entomology in SHUATS central field is situated at latitude of 25.40 and longitude of 81.85.

A Variety of Round Brinjal '*Kanshi Sandesh*' developed by IIVR Varanasi has been chosen for the field experiment. All the package of practices was followed as per the general agronomic practices. In this experiment, plant spacing of 60 x 50 $cm^2$was kept, on plot size 5x3 m^2area, with 3 replications. No pesticide was used throughout the experiment

Daily observations on insect pest were noticed from the date of transplanting to the first appearance of insects, thereafter observations were repeated at weekly interval on each Sunday and of the every week, continued till the maturity of crop.

Regular inspections and monitoring were done for observations on shoot infestation caused by the *Leucinodes orbonalis*. The withered / drooped stem depicted the initiation of shoot infestation. Total number of shoots and number of infested shoots of ten randomly selected plants from each plot were observed for shoot infestation.

Observations on shoot and fruit borer were recorded in each plot after fruit formation and continued up to maturity of crop. The numbers of healthy and damaged fruits of ten randomly selected plants were counted at each picking.

Weather data were recorded simultaneously from the Department of Agriculture Meteorology, SHUATS Allahabad. The Observations recorded on incidence of BSFB were then correlated with weather parameters. Among weather parameters, maximum temperature, minimum temperature, rainfall, relative humidity, wind speed, cloud cover and sunshine hour were considered for correlation.

The data obtained were analyzed statistically after using appropriate transformation. The percentage data were processed under Arcsine transformation before statistical analysis. Percentage of fruit damage and yield (q/ha) were calculated on the basis of following formula described bySarnabati *et al*. (2014):-

$$\textbf{\% Shoot Damage} = \frac{\text{Number of Damaged Shoot}}{\text{Total Number of Shoots (Damage + Healthy)}} \times 100$$

$$\textbf{\% Fruit Damage} = \frac{\text{Weight/number of damaged fruits}}{\text{Total Weight/number of fruits (Damage + Healthy)}} \times 100$$

The seasonal incidence of pests and weather parameters were correlated on the basis of following formula:-

$$r_{XY} = \frac{\sum XY - n\,\bar{x}\,\bar{y}}{\sqrt{\Sigma X^2 - n\bar{X}^2}\,x\sqrt{\Sigma Y^2 - n\bar{Y}^2}}$$

Where,

X = mean of 1st variable (dependent) **n = total no. of observations**

Y = mean of 2nd variable (independent) **r = correlation coefficient**

t-test for testing the significance of **'r'**

After correlation analysis we found, **r (*i.e.* correlation coefficient)**, now to check the significance of correlation we've performed t-test. Assuming the null hypothesis β=0, the value of "t" is calculated by the following expression:

$$t\{cal\} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \approx t\{tab\} with (n-2) df$$

Where,

t {cal} = calculated value of t-test of "r"

t {tab} = table value of t at (n-2) degree of freedom

n = total number of observations

r = correlation coefficient

RESULTS AND DISCUSSION

Incidence of BSFB *Leucinodes orbonalis* Guen. And percent shoot and fruit infestation:

A study on the incidence of shoot and fruit borer population in relation to weather parameters is depicted in table 4.1 and 4.2. Shoot infestation of BSFB (*Leucinodes orbonalis Guenee*) commenced from 39th standard week (1st week of October) on shoot with an average 14.94% of damaged shoot (Number basis) during commence of experiment. The borer population increased and gradually reached peak level of 44.67% of damaged shoot (Number basis) at 42nd standard week (last week of October). Also after the initiation of fruits, infestation on shoots gradually shifted to fruit during 41ststandard week to 43rdstandard week (2ndweek of October to last week of October), thereafter continuously decreasing on shoots and completely eradicated by 47th standard week (Lastweek of November), as the onset of winter. This may be due to insect's non-acclimatization in uncongenial ecological condition aroused due to change in weather.

Current study reveals that the shoot infestation of the pest occurred first time in the 40th standard week i.e. 30 days after transplanting. This is in agreement with Kaur *et al*. (2014) who reported first appearance in four week (30 DAT); However, Kumar *et al*.(2014)reported first appearance in 15 DAT and Chetan *et al.* (2017) reported the incidence on shoot started from one week after transplanting (*i.e.* during the month of November) in *Rabi* season brinjal.

Studies on the incidence of shoot and fruit borer population in relation to weather parameters are depicted in table 4.1 and 4.2. Fruit infestation of BSFB (*Leucinodes orbonalis Guenee*) commenced from 42rd standard week (3rd week of October) with an average 45.83% of damaged fruit (Number basis) and 43.43% (Weight basis) during the experiment. The borer population increased and gradually reached peak level of 57.50% of damaged fruit (Number basis) and 55.90% of damaged fruit (weight basis) at 44th standard week (1st week of November) and thereafter decline in the trend was noticed till 47th standard week. This may be again due to insect's non-acclimatization in uncongenial ecological condition aroused due to change in weather.

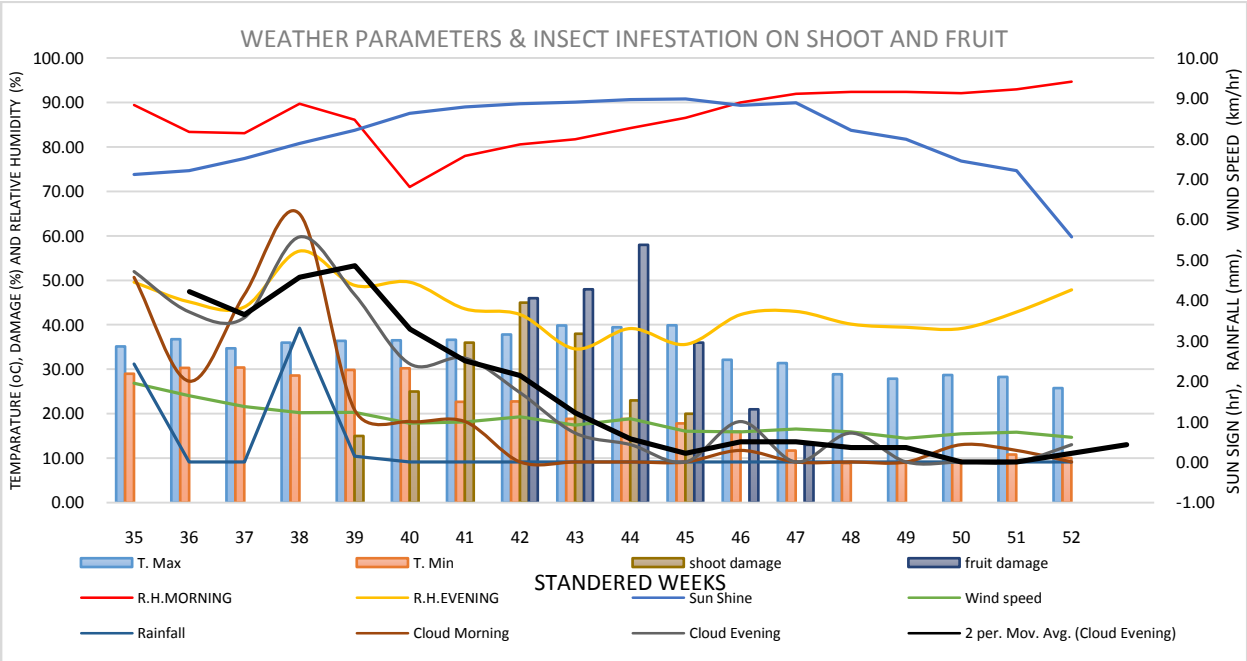
Table 1. Data of weather parameters obtained from dept. Of agriculture meteorology for the period of experiment

Standard week		Temperatures (°C)		Rain fall Mm	Humidity %		Wind speed	Cloud cover (octa)		Sun shine (hours)	%Shoot damage	% fruits Damage	
	Dates	T. Max	T. Min	24.h	Morning	Evening	KM/hr	Morning	Evening	24h	No.	No.	Wt.
36	10-09-2017	36.77	30.31	0.00	83.43	45.14	1.64	2.00	3.71	8.91	0	0	0
37	17-09-2017	37.00	30.40	0.00	83.14	44.00	1.37	4.14	3.57	8.51	0	0	0
38	24-09-2017	36.00	28.60	3.31	89.71	56.57	1.22	6.14	5.57	7.89	0	0	0
39	01-10-2017	36.40	29.86	0.14	86.14	48.86	1.23	1.29	4.14	8.61	14.94	0	0
40	08-10-2017	36.03	30.23	0.00	71.00	49.57	0.96	1.00	2.43	8.87	25.40	0	0
41	15-10-2017	36.34	22.69	0.00	78.00	43.57	0.99	1.00	2.57	8.63	35.63	0	0
42	22-10-2017	36.83	22.77	0.00	80.57	42.29	1.12	0.00	1.71	8.97	44.67	45.83	43.43
43	29-10-2017	35.03	18.86	0.00	81.71	34.57	0.91	0.00	0.71	8.97	38.43	48.48	47.68
44	05-11-2017	32.54	18.83	0.00	84.29	39.14	1.07	0.00	0.43	8.91	23.04	57.50	55.90
45	12-11-2017	32.14	17.83	0.00	86.57	35.57	0.76	0.00	0.00	8.86	19.57	36.07	36.57
46	19-11-2017	31.40	15.97	0.00	90.00	42.29	0.75	0.29	1.00	8.83	0	20.63	21.43
47	26-11-2017	28.89	11.71	0.00	92.00	43.00	0.82	0.00	0.00	8.69	0	13.43	15.59
48	03-12-2017	27.54	8.89	0.00	92.43	40.14	0.74	0.00	0.71	8.63	0	0	0
49	10-12-2017	27.89	8.97	0.00	92.43	39.43	0.59	0.00	0.00	6.86	0	0	0
50	17-12-2017	28.71	9.51	0.00	92.14	39.14	0.70	0.43	0.00	8.60	0	0	0
51	24-12-2017	28.29	10.83	0.00	93.00	42.86	0.74	0.29	0.00	8.37	0	0	0
52	31-12-2017	25.77	10.06	0.00	94.71	47.86	0.62	0.00	0.43	5.57	0	0	0

Table 2. Influence of Weather parameters On incidance of *Leucinodes orbonalis* on shoot and fruits Borer of brinjal

	Temperature (Celsius)		Rain (mm)	Relative Humidity %		Wind speed (Km/hr)	Cloud Cover (Octa)		Sun Shine (hr)
	T. Max	T. Min	24.h	MORNING	EVENING	Wind speed	MORNING	EVENING	24h
shoot	0.703	0.315	-0.184	-0.73	-0.251	0.13	-0.26	0.01	0.589
T value	3.828	1.277	0.743	4.164	1.002	0.527	1.065	0.079	2.76
T tab at5%	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131
Signif at 5%	S	NS	NS	s	NS	NS	NS	NS	S
fruit (number)	0.604	-0.035	-0.178	-0.239	-0.551	-0.017	-0.374	-0.337	0.586
T value	2.925	0.12	0.674	0.925	2.573	0.045	1.561	1.37	2.788
T tab at5%	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131
Signif at 5%	S	NS	NS	NS	S	NS	NS	NS	S
fruit (weight)	0.597	-0.043	-0.177	-0.227	-0.559	-0.027	-0.384	-0.349	0.595
T value	2.89	0.161	0.682	0.875	2.614	0.083	1.591	1.435	2.855
T tab at5%	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131	2.131
Signif at 5%	S	NS	NS	NS	S	NS	NS	NS	S

Positive correlation significantly established.
Negative correlation significantly established.



Influence of weather parameters on shoot and fruit borer (*Leucinodes orbonalis*) Incidence on shoot.

Correlation analysis was worked out by correlating 9 weather parameters in consideration and percent shoot infestations with the use of Microsoft excel and ICAR-WASP software to understand the relationship among them. The correlation coefficients thus obtained and their significance at 0.05 levels (95% confidence level) are presented in Table 4.2. It was found that the pest build up on shoot (Damage % number basis) was positively correlated with maximum temperature (r = 0.703) and sun shine hours (r = 0.589). However it was negatively correlated with morning relative humidity (r = -0.73). (Table 4.2).

Earlier various worker has revealed similar results as positive correlation of percentage infestation with maximum temperature by Shukla and Khatri, 2010 – (r = 0.319); Rao and Bhawani, 2010 – (r = 0.610);Anjali et al., 2012 – (r = 0.035); Sarnabati *et al.*, 2014 – (r = 0.129); Kumar and Singh, 2015 – (r = 0.798); Indira Kumar *et al.*, 2016 – (r = 0.035);

Kumar *et al*., 2017(a) – (r = 0.422); Ram kinker *et al.*, 2017 – (r = 0.572).

Positive correlation with sunshine hours is in agreement with, Tiwari *et al*. (2012) – (r = 0.476);Sarnabati *et al*., 2014 – (r = 0.350); Ram kinker *et al.* 2017 – (r= 0.860); Kumar *et al*., 2017(a) – (r = 0.381).

Influence of weather parameters on shoot and fruit borer (*Leucinodes orbonalis*) Incidence on fruit.

The correlation coefficients thus obtained and their significance at 0.05 levels (95% confidence level) are presented in Table 4.2. it is evident from the analysis that percent fruit infestation had positive correlation with maximum temperature (r = 0.604, on number basis and r = 0.597, on weight basis) and sun shine hours (r = 0.586, on number basis and r = 0.595, on weight basis); whereas it had negative correlation with evening relative humidity (r = -0.551, on number basis and r = 0.559, on weight basis).

Earlier various worker has revealed similar results as positive correlation of percentage fruit infestation with maximum temperature by Shukla and Khatri, 2010 – (r= 0.319), Rao and Bhawani, 2010 – (r = 0.610), Sarnabati *et al*., 2014 – (r = 0.962),Amit *et al*., 2015 – (r = 0.320), Kumar and Singh, 2015 – (r = 0.796, number basis and, r = 0.797, weight basis); Indira Kumar *et al.* (2016),Rattan*et al*., 2016 – (r= 0.490); Ram kinker *et al.*, 2017 – (r = 0.572).

Positive correlation with sunshine hours is in agreement with, Tiwari *et al*. (2012) – (r = 0.476),Kumar *et al*., 2017 – (r = 0.521);Ram kinker *et al.* 2017 – (r= 0.860).

While negative correlation with evening relative humidity was supported;Anjali et al., 2012 – (r = -0.204); Yadav *et al*., 2015 – (r = -0.116);Indira Kumar *et al.*, 2016 – (r = -0.204);Kumar *et al*., 2017 – (r = -0.632); Ram kinker *et al.* 2017 – (r = -0.536); Sharma and Tayde, 2017(b)– (r = -0.395).

REFERENCES

Amit, Y., Raghuraman, M. and Sandeeep, C. (2015). Impact of abiotic factors on population dynamics of fruit and shoot borer, *Leucinodes orbonalis* (Guen.) in brinjal, *Solanum melongena* L. *Journal of Experimental Zoology, India*, *18*(2), pp.765-768.

Anjali, M., Singh, N.P., Mahesh, M. and Swaroop, S. (2012). Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on brinjal crop. *J. Environ. Res. Develop*, *7*(1a).

Anonymous (2015). "Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare."

Atwal, A. S., and Verma, N. D. (1972). Development of *Leucinodes orbonalis* Guen. (Lepidoptera: Pyraustidae) in relation to different levels of temperature and humidity. Indian Journal of Agricultural Science, 42(9), 49–54.

Chetan, N., Gangadhar, N., Sanjeev, J. and Prafulkumar, M.V. (2017). Seasonal incidence of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guene,(Lepidoptera: Crambidae) during rabi season. *Journal of Experimental Zoology, India*, *20*(2), pp.1025-1027.

Hanson, P.M., Yang, R.Y., Tsou, S.C., Ledesma, D., Engle, L. and Lee, T.C. (2006). Diversity in eggplant (*Solanum melongena*) for superoxide scavenging activity, total phenolics, and ascorbic acid. *Journal of Food composition and Analysis*, *19*(6-7), pp.594-600.

Indirakumar, K., Devi, M. and Loganthan, R. (2016). Seasonal incidence and effect of abiotic factors on population dynamics of major insect pests on brinjal crop. *International Journal of Plant Protection*, *9*(1),pp.142-145.

Kaur, J., Kang, B.K. and Singh, B. (2014). Base line data for insecticide resistance monitoring in brinjal shoot and fruit borer, *Leucinodes orbonalis* guenee. *The Bioscan*, *9*(4), pp.1395-1398.

Kumar, K.R., Singh, N.N., Raju, S.V.S. and Mishra, V.K. (2017). Influence of Abiotic Factors on Seasonal Incidence of Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guen. in Varanasi Region. *Int. J. Curr. Microbiol. App. Sci*, *6*(4), pp.1513-1518.

Kumar, S. and Singh, D. (2015). Seasonal incidence and economic losses of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee. *Agricultural Science Digest*, *33*(2), pp.98-103.

Patel, J. R., Korat, D. M., and Patel, V. B. (1988). Incidence of shoot and fruit borer (*Leucinodes orbonalis* Guen.) and its effect on yield in brinjal. Indian Journal of Plant Protection, 16(2), 143–145.

Ramkinkar, S., Ashwani, K., Khan, H.H. and Sahu, P.S. (2017). Seasonal incidence of brinjal shoot and fruit borer, Leucinodes orbonalis Guen. under field conditions. *Journal of Experimental Zoology, India*, *20*(2), pp.709-710.

Rao, B.B. and Bhavani, B. (2010). Climate change– Likely effects on the population dynamics of brinjal shoot and fruit borer *(Luecinodes orbonalis* Guen.). *Indian Journal of Dryland Agricultural Research and Development*, *25*(2), pp.58-62.

Rattan, P., Kumar, S. and Salgotra, R.K. (2016). Role of abiotic factors in the incidence of fruit and shoot borer (Leucinodes orbonalis) Guenee in eggplant *(solanum melongena l.*) *Bioscan.* 11(4): 2721-2726

Sarnabati, L., Ray, D.C. and Singh, K.I. (2014). Seasonal incidence of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen,(Lepidoptera: Pyralidae) in Manipur. *Environment and Ecology*, *32*(3), pp.956-959.

Sharma, J.H. and Tayde, A.R. (2017). Population Dynamics of Brinjal Fruit and Shoot Borer, Leucinodes orbonalis Guen. and Hadda Beetle, Epilachna vigintioctopunctata Fab. on Brinjal at

Allahabad Agroclimatic Region. *Int J Curr Microbiol App Sci*, *6*(6), pp.2055-2060.

Shukla, A.N.J.U. and Khatri, S.N. (2010). Incidence and abundance of brinjal shoot andFruit borer Leucinodes orbonalis Guenee. *Bioscan*, *5*(2), pp.305-308.

Tiwari, G., Prasad, C.S., Kumar, A. and Nath, L. (2012). Influence of Weather Factors on Population Fluctuation of Pest Complex on Brinjal. *Annals of Plant Protection Sciences*, *20*(1), pp.68-71.

RESEARCH ARTICLE

EVALUATION THE RESIDUAL EFFECT OF CROPPING SYSTEM AND INTEGRATED NITROGEN MANAGEMENT ON SUMMER GREENGRAM (*VIGNA RADIATA* L.) IN WINTER MAIZE BASED CROPPING SYSTEM UNDER IRRIGATED CONDITION

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Abstract: A field experiment was conducted during rabi and summer seasons of 2013-14 and 2014-15 at Student's Instructional Farm Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) to find out the residual effect of integrated nitrogen management (INM) and cropping system on summer greengram in winter maize based cropping system under irrigated condition. The experiment consisted of four sole cropping (sole maize, sole potato, sole linseed and sole mustard), three intercropping systems (maize + potato, maize + mustard in 3:1 row ratio and maize + linseed grown in 3:3 row ratio) and three INM practices, viz. 100% recommended dose of nitrogen (100% RDN), 75% RDN through inorganics + 25% RDN through organics (75 + 25% RDN), and 50% RDN through inorganics + 50% RDN through organics (50 + 50% RDN). The residual effect of cropping system on growth attributes of succeeding greengram such as dry matter accumulation/plant and branches/plant, yield attributes of greengram viz., pods/plant, grains/pod, grain weight/pod, grain weight/plant and 1000-grain weight and nodules/plant and their dry weight, were recorded higher values when grown after sole potato and maize + potato in 3:1 row ratio respectively, closely followed by grown after sole linseed and plots cultivated with maize + linseed respectively, during both the years over rest of the cropping system. Grain and stover yield of succeeding greengram crop were maximized when grown after sole cropping of potato, followed by sole linseed in both the years. The corresponding values, on an average, were 0.934 and 1.417 t/ha and 0.923 and 1.398 t/ha for grain and stover yield of greengram grown after potato and linseed, respectively. Among intercropping cultivated plots, greengram grown after maize + potato recorded, on an average, higher grain yield (0.906 t/ha) and stover yield (1.359 t/ha) over greengram grown after other intercropping systems. Greengram grown after maize + linseed and maize + mustard recorded similar values of grain and stover yield. Harvest index of greengram was maximized when grown after maize + mustard intercropping system (40.56% on mean basis). Minimum harvest index of 39.51% on mean basis was recorded when greengram grown after maize + linseed intercropping system. Similar the residual effect of integrated nitrogen management (INM) on growth attributes, yield attributing characters, Number of nodules/plant and their dry weight of greengram were maximized when grown in previously fertilized plots with 50% N through inorganic urea + 50% N through organics, followed by 75% inorgainc + 25% RDN through organic in both the seasons. Previously fertilized plots with 50% N through inorganic urea + 50% N through organics recorded significantly higher values of biological (2.413 t/ha) as well as grain yield (0.973 t/ha) of greengram over remaining INM protocols. Similar trends were followed in respect of stover yield of greengram. On an average, maximum harvest index (40.30%) of greengram was recorded when grown after 50% N through inorganic urea + 50% N through organics fertilized plots, followed by 100% RDN through inorganic fertilized plots (40.03%).

Keywords: Cropping system, Integrated nitrogen management, Residual effect, *Vigna radiata* L.

INTRODUCTION

Greengram (*Vigna radiata* L.Wilczek) known as mung or mungbean in India, is the third important pulse crop of India after chickpea and pigeonpea. It is considered as wholesome among pulses, free from heaviness and flatulence. Besides its utilization as food in many forms, haulms are used as fodder and green manure. Due to its shorter duration, it can be fitted in several multiple cropping systems. Just like other pulse crops, inclusion of greengram in cropping system improves soil health and fertility (**Reddy 2009**). The seed of greengram contain 24.7% protein, 0.6% fat, 0.9% fibre and 3.7% ash (**Mohanty *et al.*, 2014**). The total area covered under greengram in India was 30.41 lakh hectares with a total production of 14.24 lakh tonnes during twelfth Plan **(Tiwari and Shivhare)**.

Summer greengram is especially help in sustaining the productivity levels of maize- greengram cropping system. The productivity of the system primarily depends on appropriate nutrient management practices. .The judicious combination of organic and inorganic sources of nitrogen in the maize-greengram cropping system was quite suitable to maintain soil fertility and productivity. Organic sources like farm yard manure and vermicompost are not only the storehouse of plant nutrient but also improve the physical-chemical properties of soil. Greengram enriches the soil through biological nitrogen fixation and organic residues. The crop is grown on marginal lands with low inputs particularly fertilizers and moisture and thus it is most suitable crop grown on residual fertility. Keeping this in view, study the application of organic sources of nitrogen with inorganic fertilizer in different maize- based

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cropping system on the especially aspects of residual effect on growth and yield of succeeding greengram has been planned (**Puste *et al.*, 2001**)

MATERIALS AND METHODS

A field experiment was conducted at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur, which is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25^0 26' to 26^0 58' North latitude and 79^0 31' to 80^0 34' East longitude at an elevation of 125.9 metres from the sea level during winter and summer seasons of 2013–14 and 2014–15 respectively. There were 21 treatment combinations comprising three intercropping systems (maize + potato, maize + mustard in 3:1 and maize + linseed grown in 3:3 row ratio), four sole cropping of maize, potato, mustard and linseed, and three integrated nitrogen management-INM practices, viz. 100% recommended dose of nitrogen (100% + 0% RDN), 75% RDN through inorganics + 25% RDN through organics (75% + 25% RDN), and 50% RDN through inorganics + 50% RDN through organics (50% + 50% RDN). These treatments were assigned in split plot design keeping 7 cropping systems in main plot and 3 INM practices in sub-plots with 3 replications. The soil was sandy loam in texture, low in organic carbon and available nitrogen, medium in available phosphorus and available potassium with slightly alkaline in reaction. The rows were oriented east-west. The rainfall during the crop season was 5.0 mm in 2013-14 and 40.8 mm in 2014-15. All crops were fertilized with recommended dose of NPK @ 150:75:60 kg for maize, 100:60:80 kg for potato, 120:60:60 kg for mustard and 100:60:40 kg ha-1 for linseed in both sole and intercrops. In case of intercropping, the fertilizer dose was adjusted for proportionate area of the intercrops. Greengram variety 'Samrat' were sown on 26 and 25 March during 2014 and 2015, respectively at same layout on previously cultivated winter crops and on residual INM practices.. The recommended seed rates of 20 kg/ha for greengram was used. Crop was irrigated as and when required. The other recommended agronomic practices were adopted to harvest the good yield.

RESULTS AND DISCUSSION

Growth Attributes

It is evident from the results revealed that the residual effect of cropping systems was found significant for growth attributes of greengram during both the years and on mean basis. The highest values of growth parameters, viz., dry matter accumulation/plant, branches/plant, number of nodules and nodule dry weight/plant of greengram were recorded at the previously grown potato, followed by linseed crop, which was significantly more than that of all maize-based intercropping systems. Similarly in intercropping treatments, maize + potato and maize + linseed grown plots proved superior to the maize + mustard grown plots in respect of growth attributes (Table 1.0).

Greengram plants accumulated maximum dry weight of 15.34 g and 15.62 g when grown after potato followed by when grown after linseed, among the intercropping system maize + potato recorded highest value (14.41 and 14.85 g) followed by maize + linseed (14.26 and 14.62g) during both seasons. The minimum dry matter (13.60 and 14.15 g) accumulated by greengram plants was recorded when grown after sole cropping of winter maize during both the years and on mean basis.

Greengram had more number of branches/plant of (4.33 and 4.39) when grown after sole cropping of potato, followed by when grown after sole linseed (4.28 and 4.36) during 2013-14 and 2014-2015, respectively, whereas in intercropping maize + potato (4.15 and 4.25) and maize + linseed (4.06 and 4.19) recorded highest value. The minimum branches/plant (3.93 and 4.06) was recorded when greengram cultivated after sole cropping of winter maize during both the years and on mean basis.

Number of nodules and nodule dry weight/plant of greengram were influenced significantly by cropping systems during both the years. Number and dry weight of nodules/plant was maximum when grown after sole potato and maize + potato intercropping system followed by when grown after sole linseed and maize + linseed intercropping system during both the years and on mean basis. Greengram when grown after sole winter maize recorded minimum number of nodules/plant and nodule dry weight/plant during both the years and on mean basis.

Table 1. Residual effect of cropping systems and integrated nitrogen management practices on growth parameters of succeeding greengram

Treatment	Dry matter accumulation at harvest (g/plant)			Branches/ plant			Number of nodules/ plant			Dry weight of nodules/ plant		
	2013-14	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*
Cropping Systems												
Sole Maize	13.60	14.15	13.88	3.93	4.06	4.00	15.47	16.12	15.79	6.12	6.45	6.29
Sole Potato	15.34	15.62	15.48	4.33	4.39	4.36	16.56	17.18	16.88	6.76	7.39	7.08
Sole Mustard	14.59	15.04	14.82	4.22	4.29	4.26	16.29	16.80	16.55	6.48	7.05	6.77
Sole Linseed	15.01	15.36	15.19	4.28	4.36	4.32	16.38	16.98	16.69	6.65	7.18	6.92
Maize + Potato (3:1)	14.41	14.85	14.63	4.15	4.25	4.20	16.14	16.70	16.42	6.38	6.93	6.66

Maize + Mustard (3:1)	13.98	14.49	14.24	4.01	4.12	4.07	15.71	16.43	16.07	6.25	6.53	6.39
Maize + Linseed (3:3)	14.26	14.62	14.44	4.06	4.19	4.12	15.93	16.59	16.26	6.35	6.77	6.56
SEd±	0.21	0.24	0.13	0.03	0.04	0.03	0.09	0.10	0.08	0.07	0.06	0.04
CD (P=0.05)	0.46	0.51	0.29	0.07	0.08	0.06	0.21	0.22	0.18	0.16	0.15	0.10
INM Protocols												
100% + 0% RDN	13.96	14.44	14.20	3.88	3.94	3.91	14.71	15.26	14.99	6.12	6.35	6.24
75% + 25% RDN	14.48	14.99	14.74	4.17	4.25	4.21	15.81	16.52	16.17	6.37	6.97	6.67
50% + 50% RDN	14.92	15.20	15.06	4.36	4.52	4.44	17.69	18.28	17.99	6.79	7.37	7.08
SEd±	0.19	0.16	0.11	0.02	0.03	0.02	0.08	0.08	0.07	0.05	0.05	0.04
CD (P=0.05)	0.42	0.37	0.24	0.05	0.05	0.04	0.18	0.017	0.016	0.13	0.12	0.10

Growth of greengram was markedly influenced by organic matter substitution in the preceding winter crops. The plot which received 50% N substitution through organics had the best expression. This treatment, however, also differed significantly with the treatments involving inorganic fertilizers (75%) substituted 25% N by organics. Further, both the INM treatments varied significantly and had higher values of growth parameters viz., dry matter accumulation/plant, branches/plant, number of nodules and nodule dry weight/plant compared to plots receiving 100% N through inorganic to winter crops. Residual effect of these INM protocols (75% + 25% RDN and 50% + 50% RDN) increased the dry matter accumulation/plant, branches/plant, number as well as weight of nodules/plant by average of 3.82 and 6.06%, 7.67 and 13.55%, 7.87 and 20.01, and 6.89 and 13.46% over previously fertilized plots with 100% N through inorganics, respectively (Table 1.0). The increase in growth attributes of greengram was owing to increased in nutrient availability through organics, as it releases major and minor nutrients slowly during entire growing season. Effectiveness of organic sources, in general, is manifested in the fact that organic matters release nutrients after mineralization which improves the physical and physic-chemical properties of soil (Yawalkar *et al.,* 1992).

Yield attributes and yield

Yield attributing characters of greengram viz., pods/plant, grains/pod, grain weight/pod, grain weight/ plant and 1000-grain weight influenced significantly due to various cropping systems. Among the sole cropping, sole potato had higher values (12.96 and 13.90, 6.26 and 7.05, 0.389 and 0.424g, 4.77 and 5.06g, 37.73 and 39.20 g respectively) of yield attributing characters of greengram, followed by sole linseed during both the years and on mean basis. In case of intercropping systems, greengram grown after maize + potato intercropping association had maximum values (12.64 and 13.72, 6.07 and 6.67, 0.369 and 0.403 g and 4.61 and 4.79 g, 35.89 and 36.87 g respectively) of all yield attributing characters, followed by greengram grown after maize + linseed system during both the years and on mean basis. Overall, minimum values of all yield attributing characters viz., pods/plant, grains/pod, grain weight/pod, grain weight/plant and 1000-grain weight (12.35 and 13.52, 5.77 and 6.36, 0.351 and 0.379g, 4.44 and 4.58g, 32.31 and 33.86 g respectively) of greengram was recorded when greengram grown after sole maize during both the years and on mean basis. (Table 2.0& 3.0).

Organic matters applied to the preceding winter crops had carry-over effect on greengram which resulted in better expression of yield attributes in plants raised in plots which had experienced substitution of nutrients through organic sources in the preceding crop(s). The highest values for all the yield attributing characters of subsequent greengram crop were recorded from the treatment receiving 50% N through inorganic and 50% N through organics in the preceding crops. The treatment which got 75% recommended dose of N through inorganics and the balance 25% N substituted through FYM and vermicompost in the equal proportion in the preceding crops also had higher values for all the yield attributes than the treatments receiving 100% N through inorganics in preceding crops (Table 2.0 & 3.0).

Table 2. Residual effect of cropping systems and integrated nitrogen management practices on yield attributes of succeeding greengram

Treatment	**Pods/ plant**			**Grains/ pod**			**Grain weight/ pod (g)**			**Grain weight/ plant (g)**		
	2013-14	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***	***2013-14***	***2014-15***	***Mean***
Cropping Systems												
Sole Maize	12.35	13.52	12.94	5.77	6.36	6.07	0.351	0.379	0.365	4.44	4.58	4.51
Sole Potato	12.96	13.90	13.43	6.26	7.05	6.65	0.389	0.424	0.407	4.77	5.06	4.84
Sole Mustard	12.73	13.77	13.25	6.13	6.87	6.50	0.374	0.410	0.392	4.65	4.86	4.76
Sole Linseed	12.79	13.84	13.32	6.20	6.98	6.59	0.382	0.414	0.398	4.70	4.96	4.83
Maize + Potato (3:1)	12.64	13.72	13.18	6.07	6.67	6.37	0.369	0.403	0.386	4.61	4.79	4.70
Maize + Mustard (3:1)	12.50	13.57	13.04	5.85	6.54	6.19	0.360	0.388	0.374	4.50	4.64	4.57
Maize + Linseed (3:3)	12.51	13.63	13.07	5.97	6.60	6.29	0.365	0.395	0.380	4.55	4.69	4.62
SEd±	0.13	0.10	0.09	0.04	0.04	0.03	0.011	0.009	0.007	0.05	0.04	0.03
CD (P=0.05)	0.29	0.24	0.20	0.09	0.08	0.07	0.024	0.20	0.015	0.11	0.09	0.07
INM Protocols	12.53	13.52	13.03	5.90	6.52	6.21	0.356	0.383	0.370	4.47	4.60	4.54

100% + 0% RDN	12.64	13.70	13.17	6.06	6.73	6.40	0.371	0.404	0.388	4.64	4.81	4.73
75% + 25% RDN	12.74	13.91	13.33	6.16	6.91	6.54	0.382	0.420	0.401	4.72	4.99	4.86
50% + 50% RDN	0.07	0.09	0.06	0.03	0.04	0.03	0.005	0.004	0.003	0.04	0.04	0.03
SEd±	0.17	0.20	0.13	0.07	0.10	0.06	0.009	0.009	0.006	0.08	0.09	0.06
CD (P=0.05)	12.35	13.52	12.94	5.77	6.36	6.07	0.351	0.379	0.365	4.44	4.58	4.51

Greengram yields varied significantly amongst different previously grown crops. Previously grown potato crop recorded the maximum yields in terms of grain and straw yield of greengram and was significantly superior to plots with sole maize and all the maize-based intercropping associations adopted in preceding season. While, treatments grown with linseed and mustard remained comparable to previously grown maize + potato in respect to greengram yields. This was due to probably overall nature of previously adopted winter crops which resulted variation in production potential of succeeding greengram crop (Table 3.0).

Grain yield was maximized under the treatments when greengram grown after sole potato, followed grown after sole linseed during both the years and on mean basis. Likewise, maize + potato intercropping system established its superiority under intercropping group and recorded on an average 1.68 and 2.14% higher grain yield of greengram over grown after maize + linseed and maize + mustard, respectively. Greengram grown after sole winter maize in succession recorded minimum grain yield during both the years and on mean basis.

It is obvious from the data revealed that greengram grown after sole cropping of potato recorded significantly higher straw yield during both the years and on mean basis. Greengram grown after sole linseed ranked on second place in respect of straw yield of greengram during 2013-14 and 2014-15 as well as on mean basis. Similar to the grain yield, straw yield also behaved in an akin fashion under intercropping group during both the seasons. Greengram grown after sole maize recorded minimum straw yield during both the years and on mean basis.

Table 3. Residual effect of cropping systems and integrated nitrogen management practices on yield of succeeding greengram

Treatment	1000-grain weight (g)			Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index (%)		
	2013-14	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*	*2013-14*	*2014-15*	*Mean*
Cropping Systems												
Sole Maize	32.31	33.86	33.09	826	913	870	1223	1386	1304	40.34	39.72	40.03
Sole Potato	37.73	39.20	38.47	869	998	934	1324	1509	1417	39.61	39.72	39.67
Sole Mustard	36.32	37.86	37.10	855	968	912	1281	1458	1370	40.02	39.86	39.94
Sole Linseed	36.84	38.54	37.70	864	982	923	1296	1500	1398	39.99	39.59	39.79
Maize + Potato (3:1)	35.89	36.87	36.38	851	960	906	1263	1451	1359	40.27	39.80	40.04
Maize + Mustard (3:1)	34.11	34.78	34.45	838	935	887	1232	1366	1299	40.49	40.61	40.56
Maize + Linseed (3:3)	35.11	36.09	35.60	840	941	891	1241	1411	1326	40.40	38.60	39.51
SEd±	1.01	0.97	0.84	0.004	0.004	0.003	0.021	0.019	0.016	0.23	0.22	0.17
CD (P=0.05)	2.22	1.99	1.72	0.010	0.009	0.007	0.044	0.041	0.036	0.51	0.46	0.37
INM Protocols												
100% + 0% RDN	34.70	35.94	35.32	801	874	838	1182	1332	1074	40.41	39.65	40.03
75% + 25% RDN	35.48	36.78	36.13	850	948	899	1286	1437	1362	39.80	39.13	39.47
50% + 50% RDN	36.24	37.51	36.88	896	1048	973	1329	1552	1441	40.28	40.32	40.30
SEd±	0.95	0.83	0.75	0.003	0.003	0.002	0.019	0.017	0.014	0.17	0.16	0.11
CD (P=0.05)	1.96	1.70	1.65	0.007	0.006	0.005	0.040	0.037	0.031	0.36	0.35	0.23

Residual of effect of INM protocols also influenced significantly on straw yield of greengram during both the years and on mean basis. Application of 50% + 50% RDN recorded significantly higher grain yield of greengram on residual fertility, which resulted in 8.23 and 16.12% higher over 75% + 25% RDN and 100% RDN alone, respectively.

On an average, application of 50% + 50% RDN to winter crops recorded significantly higher straw yield of greengram over rest of the INM protocols during both the seasons. Greengram grown on residual fertility of 100% RDN alone to winter crops registered the lowest grain and straw yield during both the years and on mean basis.

The organic matter applied in different proportions to winter crops significantly enhanced mean grain and straw yield of greengram to the extent of overall 11.69 and 30.49%, respectively over no organic treatment (Table 3.0). Higher yields of greengram was owing to better yield attributing characters viz., pods/plant, pod weight/plant, grains/pod, grain weight/pod, grain weight/ plant and 1000-grain weight as a result of improvement in soil physical, chemical and biological properties with organics. Secondly, after maize/ winter crops, the treatments having organic manures (FYM and vermicompost) might have left more nutrients in the soil than inorganic fertilizer plots, which was available for greengram crop. The results conform, Kumar (2008) and Naresh *et al*. (2013).

Based on above study suggested that greengram grown after sole potao and maize+potao intercropping system with 50% organic+50%

inorganic nitrogen management practice give higher yield under irrigated condition.

REFFERENCES

Naresh, R.K., Purushottam and Singh, S.P. (2013). Effects of integrated plant nutrient management (IPNM) practiceson the sustainability of maize-based farming systems in western Uttar Pradesh. International Journal of Researchin Biomedicine and Biotechnology 3(1): 510.

Kumar Ashok (2008). Direct and residual effect of nutrient management in maize (*Zea mays*)- wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy 53 (1): 37-41.

Yawalkar, K.S., Agrawal, J.P. and Bokde, S. (1992). Manures and fertilizers, edn 7, pp29-30. Agri Horticultural Publishing, Nagpur.

Mohanty, T.R., Roul, P.K. and Maity, S.K. (2014). Response of greengram (*Vigna radiata* L.) to establishment methods and nutrient management practices in rice – greengram cropping system. Journal of Food Legumes 27 (3):210 – 214.

Puste, A.M., Bandyopadhyay, S. and Das, D.K. (2001). Economy of Fertilizer Nitrogen through Organic Sources in Rain-Fed Rice-Legume Cropping Systems in West Bengal, India. TheScientificWorld 1 (S2): 722–727.

Tiwari, A.K. and Shivhare, A.K. (2016). RETROSPECT AND PROSPECTS. Publication No.: DPD/Pub.1/Vol. 2/pp 82 PULSES IN INDIA.

Reddy, S.R. (2009).Agronomy of field crops. Third Revised Edition, pp 329.

RESEARCH ARTICLE

IMPACT OF SEED RATES AND PLANTING METHODS ON ECONOMIC OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER IRRIGATED CONDITION

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Abstract: A field experiment was conducted to find out the economics of wheat crop with various seed rates and planting methods under irrigated condition. This experiment were laid out in split plot design with total 12 treatment combinations and replicated thrice. The treatment comprises of five planting practices (Broadcasting – M1, 25 cm Spacing – M2, 22.5 cm Spacing – M3 and 20 cm Spacing– M4) and four seed rate (100 kg ha^{-1} - S1, 125 kg ha^{-1}- S2 and 150 kg ha^{-1} -S3). The maximum gross income (Rs 71722 ha-1) was obtained at 22.5 cm apart which was higher other practices, broadcasting (Rs 39728 ha^{-1}) and 25 cm (Rs 66949 ha^{-1}). The maximum net return (Rs 47799 ha^{-1}) was recorded under the seed rate 125 kg ha^{-1} than other seed rate 100 kg ha^{-1} and 150 kg ha^{-1}, whereas the highest benefit: cost ratio recorded with 125 kg ha^{-1} seed rate which is significantly higher in comparison to 150 kg (3.30).

Keywords: Wheat, Seed rate, Planting methods, Economics

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important food grain crops in the world. In our country it is placed just after rice in terms of production and consumption. It is consumed mostly in the form of bread as "chapati". Wheat grain is a staple food used to make flour for leavened, flat and steamed breads, biscuits, cookies, cakes, breakfast cereal, pasta, noodles and for fermentation to make beer and other alcoholic beverage or bio fuel. Wheat contains more protein than other cereals and has a relatively high content of niacin and thiamine. It is basically concerned in providing the characteristics substance "glutin" which is very essential for bakers. For the production point of view India is the second wheat growing country after China in the world.

The Wheat (*Triticum aestivum* L.) is cultivated in almost every state except Kerala. Based on the agro-climatic conditions and varying agro ecological production conditions, the country is broadly divided into six wheat growing zones. The maximum wheat growing duration is in Northern Hill Zone and minimum in Peninsular Zone.

Wheat is a very adoptable crop and is grown under a wide range of soil and climatic condition. The crop is most successfully grown between latitudes of 30^0 N to 60^0 N and 27^0 S to 40^0 S in the world, with a high altitude of 5000 m. In India wheat is grown from 11^0 N to 30^0 N and from sea level up to an elevation of 3658 m in the Himalayas. In India it is grown mostly in the plains where as in the hills it is cultivated in mountainous regions of North India under a wide range of climatic conditions from Kashmir and other mountainous region to semi arid regions with mild to severe winter.

Based on the present rate of population growth of 1.5 percent and per capita consumption of 180 gm of wheat per day in the country, the demand for wheat is expected to be around 109 million tonnes by 2020. In the future scenario of climate change better agronomical practices would help in adaptation and resilience of crops. Seeding rate is one of the important production factors. Higher wheat grain yield with better quality requires appropriate seeding rate for various varieties (Radwan, 1997).Therefore, the optimum seeding rate is crucial for getting high yield of wheat in various regions (Lloveras, *et al*. 2004). Wheat is planted with different sowing methods depending upon the available resources such as soil water, time of planting, amount of preceding crop residues in the field and availability of planting machinery (Sikander *et al*., 2003). Due to differences in crop stand establishment, wheat grain yield was significantly affected by different sowing methods including broadcast and line sowing (Jan *et al*., 2001).

MATERIALS AND METHODS

A field experiment was conducted at Students Instructional Farm (SIF) of C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), during winter season of 2010-2011. The experimental plot was sandy loam in texture, having a pH of 8.0, OC 0.45% and the available NPK were analyzed to be 177.0 kg/ha, 19.50 kg/ha and 160.0 kg/ha respectively. The treatments consisting of 4 planting methods and 3 seed rate practices, the recommended dose of fertilizer (150:60:40 kg ha^{-1}) were applied, half amount of Nitrogen together with full dose of Phosphorus, Potash and Zinc were applied as basal at the time of planting in the form of Urea, DAP, MOP and Zinc sulphate respectively. Remaining half dose

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of nitrogen was top dressed into two split doses at 32 and 56 days after planting. Each net plot size was 4.50 x 4.0 m (18 m^{-2}). The crop was sown in the first week of November, 2010 and crop was harvested on last week of April, 2011.

RESULTS AND DISCUSSION

Yield:

It is clear from the table 1.0 that the maximum grain yield (41.75 q/ha) recorded in the planting method of 22.5 cm apart was significantly higher than 20 cm (40.94 q/ha) and 25 cm apart (40.61 q/ha). The straw yield did not effected significantly by planting method however the higher straw yield produce planting method 20 cm (61.11 q/ha) followed by 22.5 cm apart (59.91 q/ha) and minimum by broad casting method of planting (55.64 q/ha).

In the case of seed rate, yield affected significantly. The maximum grain yield was produced 125 kg/ha (43.28 q/ha) which was higher than 100 kg/ha (40.14 q/ha) and 150 kg/ha (39.61 q/ha). Straw yield did not affected significantly, however maximum straw yield was produced 150 kg/ha seed rate (56.91 q/ha) respectively.

The interaction effect among the methods of planting and seed rate was significantly. The maximum grain yield 42.49 q/ha was produced under method of planting 22.5 cm with seed rate of 150 kg/ha. The minimum grain yield (35.75 q/ha) were observed under the planting method of 20. cm apart and seed rate 125 kg/ha. In case of straw yield maximum straw yield was recorded under the planting method of 22.5 cm apart and seed rate 100 kg/ha in minimum straw yield was recorded 25 cm apart seed rate of 125 kg/ha. The finding conforms to Goel and Verma (2005).

Gross income:

Gross income was calculated by multiplying market price at the time of harvesting to the grain yield and by product obtained from the different plots of the experiment and the data of gross income under the different method of planting and seed rate treatment have been given in table 1.0 and fig 1 & 2.

The estimate of grass income regarding different method of planting was affected significantly. The maximum gross income (71722 Rs/ha) was obtained at 22.5 cm apart. Which was higher than other method of planting, broadcasting (69728 Rs/ha) and 25 cm (66949 Rs/ha) respectively.

Among seed rate gross income regarding different seed rate were affected significantly. The maximum gross income (69522 Rs/ha) was obtained with 125 kg/ha seed rate. Which was higher than seed rates of 150 kg/ha (68470 Rs/ha) and 100 kg/ha (66729 Rs/ha) respectively, however 125 kg/ha seed significant over 150 kg/ha seed rate.

In the case of interaction, it was also observed that the significantly maximum gross income (74446 Rs/ha) recorded under the method of planting 22.5 cm apart and seed rate of 125 kg/ha. The minimum gross income (65052 kg/ha) obtained under the planting method of 25 cm apart and seed rate of 100 kg/ha. Result conforms to Pandey and Mishra (1999).

Net profit:

Net income were obtained by subtracting the total cost of cultivation plot wise from the relative plot wise gross income and have been given in table 1.0 and fig 1.& 2.

The maximum net profit was recorded under the method of planting 22.5 cm apart as (51752 Rs/ha) which was significantly higher than other method of planting after 25 cm (46865 Rs/ha), (43254 Rs/ha) at 20 cm apart. However broadcasting did not show significant effect over 22.5 cm method of planting but it was numerically higher than other method of planting.

The maximum net profit was recorded under the different seed rate. Maximum net return was recorded under 125 k/ha seed rate as (47794 Rs/ha) then other seed rate 100 kg/ha (47753 Rs/ha) and 150 kg/ha (46466 Rs/ha) respectively. However 150 kg/ha seed did not show significant effect over 100 kg seed rate.

In interaction, It was also observed that the significantly maximum net return (51525 Rs/ha) recorded under the method of planting 22.5 cm apart and seed rate of 125 kg/ha. The minimum net return (35216 kg/ha) were observed under the planting method of 22.5 cm apart and seed rate 100 kg/ha. It confirms the finding of Pandey and Mishra (1999).

Table 1. Impact of seed rates and planting methods on grain yield, straw yield, gross return, net return (Rs/ha) and B: C ratio

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Method of planting					
M_1	36.66	58.64	68728	51752	3.46
M_2	40.94	61.11	63228	43254	3.15
M_3	41.75	59.91	71722	49755	3.49
M_4	40.61	48.21	66949	46865	3.34
SE (d)	1.05	1.09	638.8	835.20	0.14
CD at 5%	2.94	3.03	1595.70	2088.54	0.35
Seed rate					

S_1	40.14	56.04	66729	46499	3.42
S_2	42.28	56.94	68822	48466	3.46
S_3	39.61	57.97	68470	45755	3.30
SE (d)	0.82	1.88	759.60	965.20	0.09
CD at 5%	1.73	N.S.	1749.50	1913.53	0.15

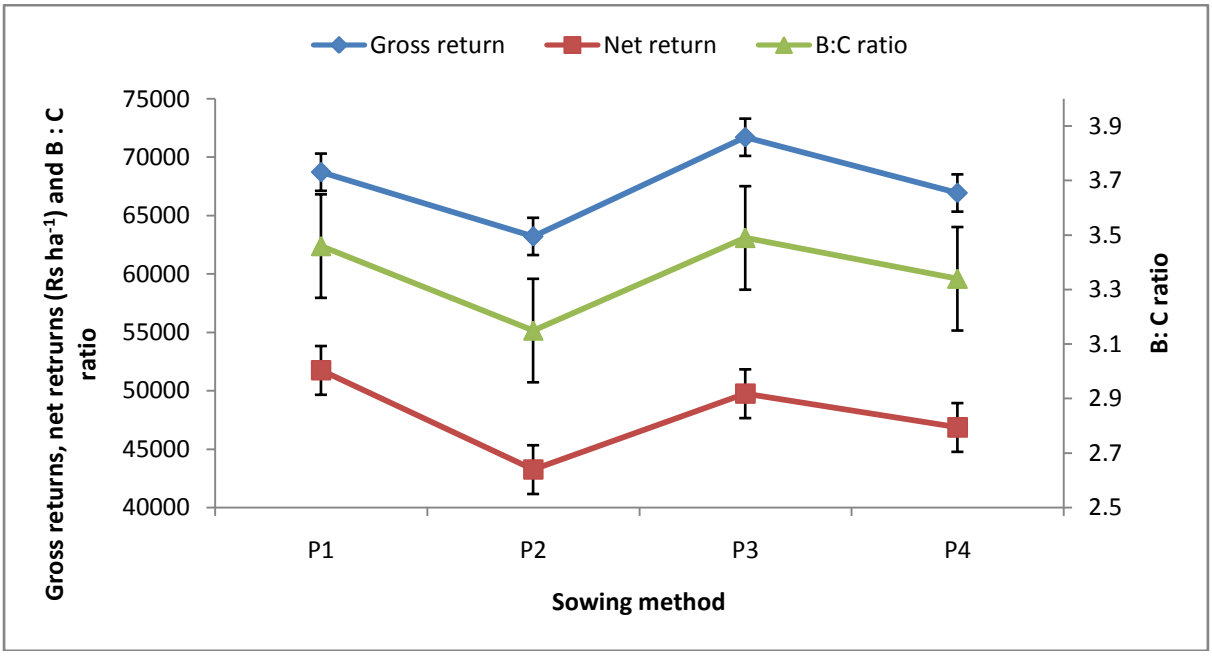

Fig-1

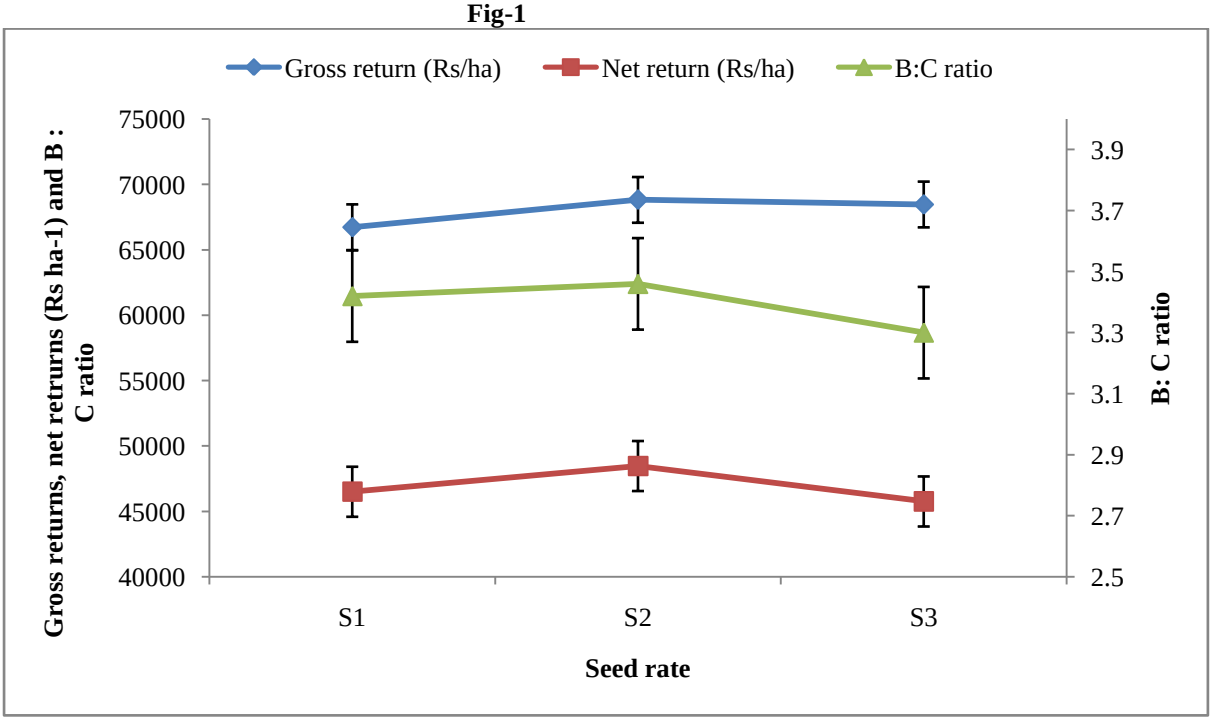

Fig-2

Benefit: Cost ratio:

From the data presented in table 1.0 and fig 1.0 and 2.0 clear that the benefit cost ratio were affected significantly various method of planting. The highest benefit cost ratio was obtained under the methods of planting 22.5 cm which was significant higher (3.49) in comparison to 25 cm (3.34). The benefit cost ratio was affected significantly under the various seed rate. The highest benefit cost ratio was obtained with 125 kg/ha seed rate which was significantly higher (3.46) in comparison to 150 kg/ha (3.30).

In the case of interaction the data showed that the high benefit: cost ratio obtain from 22.5 cm planting of crop and seed rate of 125 kg /ha (3.58) whereas minimum recorded from the planting of crop by the method of broadcasting and seed rate 125kg /ha

(3.30). Such type of finding reported Meenakshi *et al.* (2006).

CONCLUSION

Thus results of the present investigation clearly demonstrate that 22.5 cm with 125 kg seed rate can be practiced to achieve higher profit compare other methods of wheat cultivation.

REFERENCES

Goal, A. C. and Verma, K. S. (2005). Bed planting of wheat a viable planting method to improve yield and water use efficiency. Haryana Agricultural University Journal of Research. 35(1) 27 29.

Jan, M.T., H. Ali and A. Jan (2001). Influence of sowing methods and mulching on yield and yield components of wheat. Pak. J. Biol. Sci., 4: 657-659.

Lloveras, J., Manet, J., Viudas, J., Lopez, A. and Santiveri, P. (2004). Seeding rate influenced yield and yield components of irrigated winter wheat in a mediteranean climate. Agronomy Journal. 96: 1258–65.

Meenakashi, Gupta, Bail, A. S. and Kachroo, D. (2006). Performance of growth and yield of wheat (*Triticum aestivum* L.) under different planting patterns. Environment and Ecology. 24 (3) : 635 637.

Pandey, I. B. and Mishra, S. S. (1999). Effect of organic manure, fertilizer level and seed rate on yield and quality of late sown wheat (*Triticum aestivum* L). *Indian Journal of Agronomy*.44(4) : 754 759.

Radwan, F.I. (1997). Effect of seeding date and seeding rate on growth and yield of wheat (Triticum aestivum L.). Ann. Agric. Sci. Moshtohor, 35: 1079-1097.

Sikander, K.T., I. Hussain, M. Sohail, N.S. Kissana and S.G. Abbas (2003). Effect of different planting methods on yield and yield components of wheat. Asian J. Plant Sci., 2: 811-813.

Singh, V. P. and Sharma, B. D. (2008). Effect of nitrogen and seed rate on growth, yield attributes and yield of wheat varieties (*Triticum aestivum* L.). Research on Crops. 9(2) : 225 228.

RESEARCH ARTICLE

ASSESS THE EFFECT OF DIFFERENT DATES OF TRANSPLANTING AND MULCHING ON YIELD AND ECONOMICS OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.)

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Abstract: The present study was conducted during two consecutive Rabi seasons of 2016-17 and 2017-18 with aim to find out the effect of transplanting dates and mulching on fruit yield, yield parameters and economics of treatments of tomato cv. Azad T-6. The study was consisted four different dates of transplanting (D_1-15th October, D_2-31st October, D_3-15th November and D_4-30th November) and four treatments of mulch (M_1-Black polyethylene, M_2- White polyethylene, M_3- Bio Mulch (Paddy straw) and M_4-control) the experiments were laid out in Factorial Randomized Block Design. The study revealed that the crop transplanted on 30th October produced and mulching with bio mulch paddy straw produced maximum number of fruits per plant, average fruit weight and marketable fruit yield and Un-marketable fruit total yield during both the years, respectively. The crop planted on 30th October and application of bio-mulch found economic as compared to other treatments. Maximum benefit cost ratio was calculated with crop planted on 30th October and grown with bio mulch during both the years.

Keywords: Tomato. Different dates of planting, Mulching, Fruit yield, Net return

INTRODUCTION

It is one of the most popular and widely cultivated vegetable throughout the world and ranking second in importance after potato in many countries including India. The total area of world in tomato under cultivation is 4.78 m ha and total production is 177.04 m tones with 37.00 tones / ha productivity (Anonymous, 2016). In India, total area is 0.77 m ha and production is 18.73 m tones with 19.5 tones / ha productivity (Anonymous, 2016), which is very low as compared to average productivity at world level.

For the cultivation of tomato the various cultural practices followed, planting time is one of the most important factors that greatly influence its growth and yield. There is a wide range of planting time, which may affect its yield and quality due to varying climatic conditions at different stages of crop. The variation in planting time also affects the plant vigour and spread, which further affect the yield and quality of fruits. If planting time coincides with optimum ecological conditions for better germination, it may lead to better development of plants and ultimately higher yield of good quality fruits. Temperature and light intensity played a vital role in tomato plant growth, fruit set and shape of the fruits. The crop is sensitive to low and high temperature. At transplanting, low temperature leads to poor stand of crop, whereas, high temperature above 35°C affects fruit set and other important quality characteristics.

In North Indian plains and hills, transplanting of seedlings has generally done from November to February. Cold winter and danger of frost are the main hindrances in getting an early spring summer crop. In Haryana, the crop has limited period of growth from December to mid May because higher temperature during the end of May interferes with fruit set due to excessive flower drop. It has become very essential to find out the optimum date of transplanting so that the plants may be exposed to most conducive atmosphere during their growth period for fruit set and higher total yield.

Mulching is a most advantageous practice to conserve the soil moisture, organic matter to the soil where plant wastes used of mulch. Mulching tomato crops has been studied in sub-humid areas with clayey soils in India; in that environment the application of straw mulch increased tomato yields by 30% compared to un-mulched controls (Shrivastava *et al.,* 1994). A similar experiment in another sub-humid Indian region with finely textured soils found that rice straw mulch positively affects barley yields. Experiments from other countries in East Africa report similar results; the addition of mulch to shallow tillage systems improves soil conditions and yields of a variety of crops (Baijukya et al., 2006). To ensure the moisture supply mulch should be applied before the end of rainfall. This practice may increase the infiltration of rainwater and suppress the growth of weeds. Planting time also can play a vital role in producing tomato in winter season.

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MATERIALS AND METHODS

The treatment combinations consist of different dates of transplanting and types of mulches. The study was consisted for four different dates of transplanting (D_1-15th October, D_2-31st October, D_3-15th November and D_4-30th November) and four treatments of mulches (M_1-Black polyethylene, M_2- White polyethylene, M_3- Bio-Mulch (Paddy straw) and M_4-control) the experiments were laid out in Factorial Randomized Block Design.

RESULTS AND DISCUSSION

The marketable fruit yield, un-marketable and total fruit yield per hectare was influenced significantly by different planting dates (Table 1.0). The crop transplanted on 30th October produced the maximum marketable fruit yield (306.10 and 314.18 q ha^{-1}), un-marketable fruit yield (34.00 and 34.90 q ha^{-1}) and total yield (340.11 and 349.08 q ha^{-1}) as compared to late planted crop, which might be due to the availability of long period for vegetative growth and reproduction in early planted crop, as the plants accumulated more assimilates. In late transplanted crop, the temperature at flowering stage exceeded 35ºC, which impaired fruit set in tomato due to elongation of style, poor pollen production, poor pollen germination, slow pollen tube growth, lack of anthers dehiscence due to absence of endothesium layer and lack of pollination and fertilization, which led to poor fruit set and finally lower fruit yield. The results of present study confirm the findings of earlier research workers (SKadam *et al*., 1991; Hooda *et al*., 1999; Peyvast *et al*., 2001; Singh and Kumar, 2005; Singh *et al*., 2005; Hossain *et al*., 2014).

The marketable fruit yield, un-marketable and total fruit per hectare were influenced significantly by different treatments of mulch during both the years (Table 1.0).

The crop grown with bio mulch produced the maximum marketable fruit yield (295.69 and 303.54 q ha^{-1}), un-marketable fruit yield (32.85 and 33.72 q ha^{-1}) and total yield (328.54 and 337.26 q ha^{-1}) as compared to without mulch. The increased fruit yield with the application of bio mulch was probably associated with conservation of moisture and improved microclimate both beneath and above the soil surface. The suitable condition enhanced the plant growth and development and produced increased fruit bearing nodes compared to the control thereby, resulting in more fruits per plant. Gandhi and Bains (2006) reported that higher tomato fruit weight under straw mulch as compared to no mulch treatment. Norman *et al*. (2011) recorded the higher mean fruit weight of okra under dry grass mulch and the maximum mean fruit weight of pepper under sawdust mulch than the control. Dzomeku *et al*. (2009) indicated that straw mulch increased the fruit yield in both pepper and tomato.

Table 1. Marketable, Unmarketable and Total yield (q/ha)

S. No.	Treatment	Marketable, Unmarketable and Total yield (q/ha)					
		Marketable Yield		Unmarketable Yield		Total Yield	
Factor A	**Date of Transplanting**	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
D_1	15 October	259.29	266.17	28.80	29.60	288.10	295.74
D_2	30 October	306.10	314.18	34.00	34.90	340.11	349.08
D_3	15 November	284.02	291.70	31.55	21.40	315.58	313.10
D_4	30 November	242.36	248.90	26.92	27.65	269.28	276.55
	SE (d)	**3.83**	**5.09**	**0.78**	**0.93**	**4.18**	**5.53**
	CD (P = 0.05)	**7.83**	**10.40**	**1.61**	**1.91**	**8.54**	**11.31**
Factor B	**Mulches**						
M_1	Black Polyethylene	279.01	286.40	30.99	31.85	310.01	318.22
M_2	White Polyethylene	266.91	274.08	29.65	30.45	296.56	304.53
M_3	Bio Mulch (Paddy straw)	295.69	303.54	32.85	33.72	328.54	337.26
M_4	Control (No Mulching)	250.16	256.92	27.79	28.54	277.95	285.46
	SE (d)	**3.83**	**5.09**	**0.78**	**0.93**	**4.18**	**5.53**
	CD (P = 0.05)	**7.83**	**10.40**	**1.61**	**1.91**	**8.54**	**11.31**

Gross return

Maximum gross return (Rs. 306102.50 and 314180.00 ha^{-1}) was computed under the treatment D_2 (30 October planted) followed by D_3 (15 November) and minimum gross return ha^{-1} (Rs. 242360.00 and 248902.50) was computed under the treatment D_4 (control) respectively during both the year of experimentation.

Among, different treatments of mulches, application of bio-mulch (Paddy straw) computed maximum gross return (295692.50 and 303547.50 Rs ha^{-1}) and minimum was recorded (250162.50 and 256927.50 Rs ha^{-1}) under the treatment D_4 (control) during both the years.

Net income

The highest net return (Rs. 219385.50 ha^{-1}) was computed under the treatment D_3 (15 November) in Y_1 and (Rs 249538.00 ha^{-1}) in D_2 (30 October) during Y_2. Minimum net return (Rs. 177717.83 and 183760.50 ha^{-1}) was calculated with in the treatment D_4 control during both the year of investigation.

Among mulching treatments maximum (Rs 211050.50 and 2389.5.50 ha^{-1}) net income computed with application of bio mulch (Paddy straw) (M_3) and minimum (Rs186520.50 and 193285.50 ha^{-1}) without application of mulch (M_4) during both the years, respectively.

Table 2. Economics of different treatments

S. No.	Treatment	Economics of different treatments						
		Cost of cultivation	Gross Income (Rs/ha)		Net Income (Rs/ha)		B:C Ratio	
Factor A	**Date of Transplanting**		**2016-17**	**2017-18**	**2016-17**	**2017-18**	**2016-17**	**2017-18**
D_1	15 October	64417.00	259297.50	266177.50	194655.50	201535.50	3.01	3.11
D_2	30 October	64642.00	306102.50	314180.00	211460.50	249538.00	3.73	3.86
D_3	15 November	64642.00	284027.50	291702.50	219385.50	207060.50	3.39	3.51
D_4	30 November	64642.00	242360.00	248902.50	177717.83	183760.50	2.75	2.85
	SE (d)	**156.47**	**2141.17**	**2444.46**	**2207.64**	**2403.31**	**0.17**	**0.19**
	CD (P = 0.05)	**N.S.**	**4374.06**	**4993.66**	**4509.86**	**4909.58**	**0.34**	**0.39**
Factor B	**Mulches**							
M_1	Black Polyethylene	64917.00	279017.50	286405.00	213875.50	220762.50	3.28	3.39
M_2	White Polyethylene	65142.00	266915.00	274082.50	201773.00	208940.50	3.09	3.20
M_3	Bio Mulch (Paddy straw)	64642.00	295692.50	303547.50	211050.50	238905.50	3.57	3.69
M_4	Control (No Mulching)	63642.00	250162.50	256927.50	186520.50	193285.50	2.93	3.03
	SE (d)	**156.47**	**2141.17**	**2444.46**	**2207.64**	**2403.31**	**0.17**	**0.19**
	CD (P = 0.05)	**319.65**	**4374.06**	**4993.66**	**4509.86**	**4909.58**	**0.34**	**0.39**

Benefit cost ratio

Maximum benefit cost ratio (3.73 and 3.86) was computed under the treatment D_2 (30 October) followed by D_3 (15 November) during both the years, respectively. The minimum benefit cost ratio (2.75 and 2.85) was obtained under the treatment D_4 (30 November transplanting) during both the years.

Among mulches application of bio mulch (M_3) found economical with benefit cost ratio (3.57 and 3.69) and minimum (2.93 and 3.03) with M_4, without mulching during both the years, respectively.

The higher gross returns, net returns and B: C ratio with black polythene mulch which might be attributed to higher early and total yield. These results are in confirmity with the findings of Singh *et al*. (2009), Choudhary and Bhambri (2012), Bora and Babu (2014) and More *et al*. (2014).

CONCLUSION

Finally it may be concluded from the present investigation the crop planted on 30th October and application of bio-mulch found economic as compared to other treatments. Maximum benefit cost ratio was calculated with crop planted on 30th October and grown with bio-mulch during both the years.

REFERENCES

Anonymous (2016). Statewise Area and Production of Vegetable for the year 2016-17. *Indian Horticulture Database-2014*. National Horticulture Board, Gurgaon, Haryana. pp: 283.

Baijukya, F. P., de Ridder, N. and Giller, K. E. (2006) 'Nitrogen Release from Decomposing Residues of Leguminous Cover Crops and their Effect on Maize Yield on Depleted Soils of Bukoba District, Tanzania', Plant and Soil, **279**(1), pp. 77-93

Choudhary, V.K., Bhambri, M.C., Pandey N. and Sharma, H.G. (2012). Effect of drip irrigation and mulches on physiological parameters, soil temperature, picking patterns and yield in capsicum (*Capsicum annuum* L.). *Archives of Agronomy and Soil Science*, **58**(3): 277-292.

Dzomeku, I.K., Mahunu, G.K., Bayorbor, T.B. and Obeng-Danso, P. (2009). Effects of mulching on weed control and yield of hot pepper and tomato in the Guinea Savannah zone. *Ghana Journal of Horticulture*, **7**: 53-61.

Gandhi, N. and Bains, G.S. (2006). Effect of mulching and date of transplanting on yield contributing characters of tomato. *Journal of Research* PAU, India, **43**: 6-9.

Hooda, R.S., Singh, J., Malik, Y.S. and Batra, V.K. (1999). Influence of direct seeding transplanting time and mulching on tomato yield. *Vegetable Science*, **26**: 140-42.

Hossain, M.F., Ara, N., Uddin, M.S., Islam, M.R. and Kaisar, M.O. (2014). Effect of sowing dates on fruit setting and yield of tomato genotypes. *Journal of Agricultural Research*, **52**(4): 547-553.

Kadam, D., Deore, B. and Chaudhari, S. (1991). Effects of sowing date and staking on yield of tomato (*Lycopersicon esculentum* Miller). *Indian Agriculturist*, **33**: 225-230.

More, S.J., Gohil, J.H., Bhanderi, D.R., Patil, S.J. and Tekale, G.S. (2014). Productivity and profitability of tomato (*Lycopersicon esculentum*

Mill.) influenced by various transplanting dates and mulches. *Trends in Biosciences*, **7**(17): 2376-2381.

Norman, J.C., Opata, J. and Ofori, E. (2011). Growth and yield of okra and hot pepper as affected by mulching. *Ghana Journal of Horticulture*, **9**: 35-42.

Peyvast, G.H. (2001). Study of some quality and quantity factors of tomato. *Journal of Vegetable Crop Production*, **10**: 15-22.

Shrivastava, P., Parikh, M., Sawani, N. and Raman, S. (1994) 'Effect of drip irrigation and mulching on tomato yield', Agricultural Water Management, 25(2), pp. 179-184

Singh, R. and Kumar, S. (2005). Effect of transplanting time and mulching on growth and yield of tomato. *Indian Journal of Horticulture*, **62**(4): 350-353.

SHORT COMMUNICATION

ANTIMICROBIAL ACTIVITY OF CITRUS FRUITS ON CERTAIN PATHOGENIC MICROORGANISM

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Abstract: The main objective of present study was to study the antibacterial effect of *Citrus limon* juice extract against *Escherichia coli*, *Salmonella*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus pyogenes*. Extract of *Citrus limon* juice was prepared for antibacterial study and Norfloxacin was taken as control antibiotic. The antibacterial activity of *Citrus limon* juice extract was detected by using agar well diffusion method. In the present study it was observed that *Citrus limon* juice extract showed maximum antimicrobial activity against *Staphylococcus aureus* which was 115% more as compared to Norfloxacin (10mg/ml). Similar results have been observed against bacteria such as *Salmonella*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus pyogenes*. These results confirmed that *Citrus limon* is a very important and effective medicinal plant against bacterial.

Keywords: *Citrus limon, Pseudomonas aeruginosa, Proteus vulgaris, Staphylococcus aureus, Streptococcus pyogenes*

INTRODUCTION

Citrus limon is a conventional fruit which belong to plant family *Rutaceae* and is commercially know as sweet orange. *Citrus sp.* is a spreading evergreen, sometimes spiny trees which could be 12m tall with oral elliptic leaves and rounded fruits that are up to 12cm in diameter (Susser, 1997). Okwu (2008) investigated that citrus trees are evergreen trees that produce fruits of different forms and sizes (from round to oblong), which are full of fragrance, flavor and juice. Chanthaphon *et al.* (2008) reported that citrus fruit belong to six genera (*Fortunella, Eremocitrus, clymendia, poncirus, Microcitrus and citrus*), which are native to the tropical and subtropical regions of Asia, but the major commercial fruits such as oranges, mandarins, lime, lemons and grape fruits. Mandalari *et al.* (2006) reported that orange constitute about 60% of the total citrus world production.

Adode (2002) observed that fruits contain 80 to 90% sugar and acids, citric acid are abundant acid in the sap. Roger (2002) reported that the internal constitutes the pulp which is rich in soluble sugars, ascorbic acid, pectin, fibers, different organic acids and potassium salt that gives the fruit its characteristics citrine flavor. Hasija *et al.* (2015) reported that citrus peel oil can be used as natural preservative to minimize the ill effects of these synthetic preservatives and protect consumer health.

The emergence of multidrug resistance bacterial strains are also becoming a global concern, with particular emphasis on *E. coli* (Ithete *et al*., 2013), *Salmonella* (Zaki and Karande, 2011), *Pseudomonas aeruginosa* (Hirsch and Tam, 2010), *Proteus vulgaris* (Mandal *et al*., 2015), *Staphylococcus aureus* (Neyra *et al*., 2014), *Streptococcus pyogenes* (Pieretti *et al*., 2017). The increasing occurrence of multidrug resistant strains of bacteria and the recent appearance of strains with reduced susceptibility to antibiotics raises the spectra of untreatable bacterial infections and adds urgency to the search for new infection-fighting and safe strategies (Janovská *et al*., 2003, Deshwal and Vig, 2011, Deshwal, 2013).

Suja *et al.* (2017) investigated that Citrus fruit are highly nutritious medicinal plant and found to be commonly in cultivation throughout the tropic. Hindi and Chabuck (2013) have demonstrated the antimicrobial effects of aqueous extracts of peel and juice from fresh and dried citrus and sweet lemon against gram-positive and gram-negative bacteria and yeast isolates, including *Staphylococcus aureus, Enterococcus faecalis, Salmonella typhi, E.coli and Candida albicans*. So aim of present study is to evaluate antimicrobial activity of citrus fruits on certain pathogenic microorganism

MATERIALS AND METHODS

Collection of test pathogenic microorganisms: Characterized *Escherichia coli, Salmonella, Pseudomonas aeruginosa, Proteus vulgaris, and Staphylococcus aureus* were collected from Microbiology department, BFIT, Dehradun and *Streptococcus pyogenes* culture was obtained from the IMTEC Chandigarh (MTCC NO. 1926).

Collection of plant materials: Freshly *Citrus limon* was purchased from the local market of Dehradun.

Preparation of extracts: The fresh fruits were washed in running tap water in laboratory, surface sterilized with 70% alcohol, rinsed with sterile distilled water and cut open with a sterile knife and the juice pressed out into a sterile universal container separately and then filtered into another sterile container to remove the seeds and other tissues and used freshly as crude without refrigeration (Hindi and Chabuck, 2013).

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Activation of test organism: The microorganism was activated by inoculating a loop full of the strain in the nutrient broth and incubated on a rotary shaker for 24hrs at 37°C.

Evalution of Antimicrobial activity using Agar well diffusion method:

The screening of antimicrobial activities of juice extract against test microorganism was determined on Muller-Hinton agar media, by agar well diffusion method. Sterilized Muller-Hinton agar media was poured into sterilized petriplate. After solidification of medium, 0.5ml (10^6 bacteria/ml) bacterial culture was spreaded on Muller-Hinton agar media. Wells of 7mm depth were made on the solid agar using a sterile borer. About 100µl of *Citrus limon* juice extract and Norfloxacin was transferred into the wells separately by using sterile pipette. The plates were allowed to stand for one hour for a pre-diffusion of extracts and were incubated at 37°C for 24 hrs. After incubation, the plates were collected and the zones of Inhibition were measured.

Table 1. Antimicrobial activity of *Citrus limon* juice against certain test organisms

Test organism	Zone of Inhibition (mm)				
	Citrus limon juice				Norfloxacin (10mg/ml)
	I	II	III	Mean ± S.D	
Escherichia coli	14	14	13.5	13.8±0.28	08.00
Salmonella	21	21	21	21.0±0.00	13.60
Pseudomonas aeruginosa	17	17	16	16.6±0.57	13.30
Proteus vulgaris	22	18	20	20.0±2.00	13.00
Staphylococcus aureus	29	28	29	28.6±0.57	13.30
Streptococcus pyogenes	23	22	22	22.3±0.57	15.00

RESULTS AND DISCUSSION

Present study shows that *Citrus limon* juice extract significantly inhibited the growth of Gram positive and Gram negative bacteria. *C. limon* juice extract showed maximum antimicrobial activity against *Staphylococcus aureus* which was 115% more as compared to Norfloxacin (10mg/ml). Similarly, *C. limon* juice extract showed 72.5, 54.4, 24.8, 53.8, 48.6 % more inhibition zone in *Escherichia coli*, *Salmonella*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Streptococcus pyogenes* respectively as compared to Norfloxacin (10mg/ml). All these results confirmed that *Citrus limon* juice extract effectively inhibited growth of pathogenic *Escherichia coli*, *Salmonella*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus pyogenes* (Table 1). Medicinal plants are good alternative of chemical antibiotics. In present study showed that *Citrus limon* juice effectively control growth of various pathogens such as *Escherichia coli*, *almonella*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus pyogenes*. Similar research studies have shown that several medicinal plants inhibited growth of bacterial pathogens (Deshwal and Vig, 2011a, Deshwal and Vig, 2011b, Deshwal, 2012).

CONCLUSION

Present study showed that *Citrus limon* juice extract significantly inhibited the growth of various Gram positive and Gram negative bacteria. Use of antibiotic has side effect to human and medicinal plants are good alternative of chemical antibiotics.

REFERENCES

Deshwal, V.K. and Vig, K. (2011a). Screening for Antibacterial activity of seeds of *Tribulus terrestris* L. growing in Uttarakhand (INDIA). *International Journal of Pharmaceutical Invention*, **1(1)**: 42-46.

Susser, G.O. (1997). The Great Citrus Book. A Guide with recipes. Ten Speed Printing Press.

Okwu, D.E. (2008). Citrus Fruits: A rich source of Phytochemicals and their roles in Human Health. *International Journal of Chemical Science*, **6(2)**: 451-471.

Chanthaphon, A., Chanthachum, S. and Hongpattarakere, T. (2008). Antimicrobial activities of essential oils and crude extracts from tropical *Citrus spp.* against food- related microorganism. *Songklanakarin Journal of Scienece and Technology*, **30(1)**:125-131.

Mandalari, G., Bennett, R.N., Bisignano, G., Saija, A., Dugo, G., Faulds, C.B. and Waldron, K.W. (2006). Characterization of flavonoids and pectin from bergamot (*Citrus bergamia Risso*) peel, a major byproduct of essential oil extraction. *Journal of Agriculture And Food Chemistry*. **54**:197-203.

Adode, A. (2002). Nature Power: Revised Edition. Don Bosco Training Centre, Akure: 1-98.

Roger, G.D.P. (2002). Encyclopedia of Medicinal Plant, Education and Health Library Editorial Safeliz S.L. Spsin, **265(1)**:153-154.

Hasija, S., Ibrahim, G. and Wadia, A. (2015). Antimicrobial Activity of *Citrus sinensis* (orange),

Citrus limetta (Sweet Lime) and *Citrus limon* (lemon) Peel oil on Selected Food Borne Pathogens. *International Journal of life Science Research*, **3(3)**: 35-39.

Ithete, N.L., Stoffberg, S., Corman, V.M., Cottontail, V.M., Richards, L.R., Schoeman, M.C., Drosten, C., Drexler, J.F. and Preiser, W. (2013). Multidrug-Resistant *Escherichia coli* Bacteremia. *Emerging Infectious Diseases*, **19**:1699-1701.

Zaki, S.A. and Karande, S. (2011). Multidrug-resistant typhoid fever: A review. *The Journal of Infection in Developing countries*, **5(5)**: 324-337.

Hirsch, E.B. and Tam, V.H. (2010). Impact of multidrug-resistant *Pseudomonas aeruginosa* infection on patient outcomes. *Expert Review of Pharmacoeconomics Outcomes Research*, **10(4)**: 441-451.

Mandal, D., Dash, S.K., Das, B., Sengupta, M., Kundu, P.K. and Roym, S. (2015). Isolation and Characterization of multi-drug resistance *Proteus vulgaris* from clinical samples of UTI infected patients from midnapore, West Bengal. *International Journal of Life Science and Pharma Research*, **5(2)**: l32-l45.

Neyra, R.C., Frisancho, J.A., Rinsky, J.L., Resnick, C., Carroll, K.C., Rule, A.M., Ross T., You, Y., Price, L.B. and Silbergeld, E.K. (2014). Multidrug-Resistant and M ethicillin-Resistant *Staphylococcus aureus* (MRSA) in Hog Slaughter and Processing Plant Workers and Their Community in North Carolina (USA). *Environmental Health Perspectives* (http://dx.doi.org/10.1289/ehp.1306741). : 1-32.

Pieretti, B., Canovari, B., Moretti, M., Pieretti, C. and Pazzaglia, E. (2017). Drug-resistant *Streptococcus pyogenes*: a case report of pyoderma and Cellulitis. *Microbiologia Medica*, **32**: 112-113

Janovská, D., Kubīková, K. and Kokośka, L. (2003). Screening for antimicrobial activity of some medicinal plants species of traditional Chinese medicine, *Czech Journal of Food Science*. **21**, 107-110.

Deshwal, V.K. and Vig, K. (2011a), Screening for Antibacterial activity of seeds of *Tribulus terrestris* L. growing in Uttarakhand (INDIA), *International Journal of Pharmaceutical Inventation*, **1(1)**: 42-46.

Deshwal, V.K. (2013). Antibacterial investigation of black pepper against *Shigella dysenteriae*. *Journal of Plant Development Sciences*, **5(1)**: 89-90

Suja, D., Bupesh, G., Rajendiran, N., Mohan, V., Ramasamy, P., Muthiah, N.S, Elizabeth, A.A., Meenakumari, K. and Prabu, K. (2017). Phytochemical Screening, Antioxidant, Antibacterial Activities of *Citrus Limon* and Citrus Sinensis Peel Extracts. *International Journal of Pharmacognosy Chinese Medicine*, **1(2)**:108.

Hindi, N.K.K. and Chabuck, Z.A.G. (2013). Antibacterial activity of different aqueous Lemon extracts. *Journal of Applied Pharmaceutical Science*, **3(06)**:074-078.

Deshwal, V.K. (2013). Antimicrobial investigation of *Piper nigrum* L. against *Salmonella typhi*. *Journal of Drug Delivery and therapeutics* (JDDT). **3(3)**: 100-103.

Deshwal, V.K. and Siddiqui, M.M.M. (2013). Screening and evaluation of anti-microbial activity in *Tylophora indica*. *Journal of Plant Development Sciences*. 5(2): 223-225.

Deshwal, V.K., Vig, K., Singh, S.B. and Devi, P.D. (2012). Evaluation of the Antibacterial Activity of bark of *Litchi chinensis* against *Escherichia coli*, a UTI causing Organism. *Journal of plant development sciences*, **4(1)**: 101-103.

Deshwal, V.K. and Vig, K. (2011a). Screening for Antibacterial activity of seeds of *Tribulus terrestris* L. growing in Uttarakhand (INDIA). *International Journal of Pharmaceutical Invention*, **1(1)**: 42-46.

Deshwal, V.K. and Vig, K. (2011b). Isolation and characterization of Urinary tract infection (UTI) causing pathogens and their comparative study in different genders. *Development Microbiology and Molecular Biology*, **2(2)**: 113-116.

Deshwal, V.K. (2012b). Antibacterial activity of *Piper nigrum* Linn. against *E. coli* causing Urinary tract infection. *International Journal of Pharmaceutical Invention*, **2(2)**: 1-7.

SHORT COMMUNICATION

COMPARATIVE STUDY OF MICROBIAL CONTAMINATION IN FRUIT JUICE IN LOCAL MARKET AT DEHRADUN

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Abstract: The aim of the present study is microbial analysis of freshly prepared orange juices sold in the markets of Dehradun (Uttrakhand). Bacterial count and yeast count has been done by spread plate method and pour plate method. Isolated strains were characterized on the basic of microscopy and certain biochemical tests. Orange juice at suddhowala showed more microbial count as compared to premnagar, Dehradun. Microscopy examination and biochemical tests confirmed that Orange juice collected at Suddhowala contained *Escherichia coli*, *Staphylococcus aureus*, *Saccharomyces cerevisiae* and *Penicillium sp.* but *Lactobacillus sp.*, *Salmonella sp*., *Saccharomyces cerevisiae*, *Aspergillus niger* were isolated from Orange juice at Premnagar. Our results clearly, suggested that orange juice at local market contained various type of microbial contaminant and such type of orange juice is not good for health.

Keywords: Orange, *Saccharomyces cerevisiae*, *Penicillium sp.*, *Lactobacillus sp.*, *Salmonella sp*., *Aspergillus niger*

INTRODUCTION

India produces about 9 million tons of fruits every year growing at a rate of 12% per annum. The total market potential for fruit juices is 230 million liter including both packed and freshly made fruit juices (Keshari, 2010). Fruit juices are an important part of human diet due to it's highly nutritious and offer a good taste (Tasnim *et al.*, 2010). These fruit juices are fat-free and contain naturally occurring phytonutrients contributing to better health (Franke *et al.*, 2005).

Contamination from raw materials and equipments, additional processing conditions, improper handling, prevalence of unhygienic conditions contributes substantially to the entry of bacterial pathogens in juices (Oliveira *et al.*, 2006). The type of microorganisms in fruit juice is greatly of microorganisms in the respective fruits. Fruits commonly carry mold, yeasts and bacteria (Hariyadi, 2013). Further, few reports suggested that food-borne illnesses is associated with the fruit juice consumption (Chumber *et al.*, 2007). Foodborne diseases are the illnesses contracted from eating contaminated food or beverages. These food borne diseases is armful illness mainly affecting the gastrointestinal tract. Improper washing of fruits add bacteria to extracts leading to contamination. Further, In addition, use of contaminated water, unhygienic surroundings often with swarming houseflies, airborne dust and environment can act as sources of contamination. Such juices have shown to be potential sources of various bacterial pathogens such as *Salmonella*, *E. coli*, *Shigella*, and *S. aureus* (Buchmann *et al*., 1999, Sandeep *et al*., 2002, Barro *et al*., 2006).

So, aim of present study is comparative study of microbial contamination in fruit juices in local market at Dehradun.

MATERIAL AND METHODS

Collection of fruit juice: Local market juice samples were purchased from premnagar and Suddhowala at Dehradun city. These samples were collected in sterile screw cap containers and transported under refrigeration to laboratory where they were immediately examined for microbiological analysis.

Isolation and Microbial counting of contamination in orange juice: 1 ml of juice sample was serially diluted were placed on nutrient agar plates and potato Dextrose Agar by spread plate method and pour plate methods. The experiment was carried out in triplicates for each of the sample. The NAM plates were then incubated at 37°C for 24 hours and PDA plates were incubated at 26°C for 7 days. The total colony counts were determined on plate count agar (PCA) by spread plate method for bacteria and plates were incubated at 37°C and the colonies were counted after 48 hours of incubation.

Purification of microorganism from juice: Microorganisms were purified on Nutrient agar medium or sabouraud dextrose agar medium at 37°C and at 26°C respectively for bacteria and fungi.

Characterization of microorganisms: Isolated strains were characterized on the basis of biochemicals tests (Holt *et al*., 1994).

RESULTS AND DISCUSSION

Although fruit juices are potential for human health, but over their hygiene, safety and quality much concerns have been raised in present scenario. In local market as well as in home people only think about the nutritional benefits but not quality of the juice.

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Orange juice at suddhowala showed more microbial count as compared to premnagar, Dehradun. Total viable count of microorganisms in orange juice was variable in suddhowala and premnagar. In, suddhowala total viable count was 420 bacteria, 240 yeast and 60 mold but less total viable count of microorganism in orange juice which was collected at premnagar i.e. 200 bacteria, 145 yeast and 50 mold (Table 1). These strains were characterized on the basis of microscopy and biochemical tests. Results suggested that Orange juice collected at Suddhowala contained *Escherichia coli*, *Staphylococcus aureus*, *Saccharomyces cerevisiae* and *Penicillium sp.* but *Lactobacillus sp.*, *Salmonella sp*., *Saccharomyces cerevisiae*, *Aspergillus niger* were isolated from Orange juice at Premnagar. Similarly, Aneja *et al.* (2014) examined 30 juice samples and isolated twenty-five microbial species including 9 bacterial isolates, 5 yeast isolates, and 11 mould isolates. *Aspergillus flavus* and *Rhodotorula mucilaginosa* were observed in the maximum number of juice samples. Among bacteria *Bacillus cereus* and *Serratia* were dominant. *Escherichia coli* and *Staphylococcus aureus* were detected in few samples (Aneja *et al.*, 2014). Similarly, other report confirmed that Fruit juice contained various microorganisms (Raybaudi-Massilia *et al.*, 2009, Castillo *et al*., 2016, Ogodo *et al*., 2016, Nma *et al*. 2017, Beuchat (1996), Beuchat, 2002), Brayant, 2007).

CONCLUSION

Our results suggested that orange juice at local market contained various type of microbial contaminant. Such local juice shop keeper does not maintain hygienic condition and such contaminated orange juice can be harmful for human.

Table 1. Total viable count of freshly collected orange juice

Local Market at Dehradun		**Microbial Count/ml**		
Fruit juice	Place of sample collection	Bacteria	Yeast	Mold
Orange juice	Suddhowala	420	240	60
Orange juice	Premnagar	200	145	50

REFERENCES

Keshari, A.K. (2010). A comparative study on fruit juices. *Institute of Management Studies*, **15**:733-737.

Tasnim, F. Jr, Hossain, M.A., Nusrath, S., Hossain, M.K., Lopa, D. and Formuzul Haque, K.M. (2010). Quality Assessment of Industrially Processed Fruit Juices Available in Dhaka City, Bangladesh. *Malaysian Journal of Nutrition*, **16(3)**:431-438.

Franke, A.A., Cooney, R.V., Henning, S.M. and Custer, L.J. (2005). Bioavailability and antioxidant effects of orange juice components in humans. *Journal of Agriculture Food Chemistry*, **53(13)**: 5170–5178.

Oliveira, A.C.G., Seixas, A.S.S., Sousa, C.P. and Souza, C.W.O. (2006). Microbiological evaluation of sugarcane juice sold at street stands and juice handling conditions in Sao Carlos, Sao Paulo. *Brazil. Cad. Saúde Pública , Rio de Janeiro*, **22(5)**:1111-1114.

Hariyadi, R.D. (2013). Microbiological Quality and Safety of Fruit Juices. *Food Review International*, **1**:54-57.

Chumber, S. K., Kaushik, K. and Savy, S. (2007). Bacteriological analysis of street foods in Pune. *Indian Journal of Public Health*, **51(2)**: 114-116.

Buchaman, R.L., Edelson, S.G., Miller, R.L, and Sapers, G. M. (1999). Contamination of intact apples after immersion in an aqueous environment containing *Escherichia coli* O157:H7. *Journal of Food Protection*, **62**: 444-450.

Sandeep, M., Diwakar. A. and Abhijit, G. (2002). Microbiological Analysis of Street Vended Fresh squeezed Carrot and Kinnow-Manderian Juices in Patiala City, India. *International Journal of Food safety*, **3**: 1-3.

Barro, N., Bello, A.R., Aly, S., Ouattara, C. A. T., Ilboudo A.J. and Traoré, A. S. (2006). Hygienic status an assessment of dishwashing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso). *African Journal of Biotechnology*, **5 (11)**: 1107-1112.

Holt, J.G., Krieg, N.R., Sneath, P.H.A., Staley, J.T. and Williams, S.T. (1994). Bergey's Manual of Determinative Bacteriology, 9th ed. Williams and Wilkins, Baltimore, Maryland.

Aneja, K.R. (2014). Microbes associated with freshly prepared juices of citrus and carrots. *International Journal of Food Microbiology*, **14**:1-7.

Raybaudi-Massilia, R.M., Mosqueda-Melgar, J., Soliva-Fortuny, R. and Martín-Belloso, O. (2009). Control of pathogenic and spoilage microorganisms in fresh-cut fruits and fruit juices by traditional and alternative natural antimicrobials," *Comprehensive Reviews in Food Science and Food Safety*, **8(3)**:157-180.

Castillo, A., Villarruel-Lo´pez, A., Navarro-Hidalgo, V., Marti´nez-Gonza´Lez, N. E., and Torres-Vitela, M. R. (2016). *Salmonella* and *Shigella* in Freshly Squeezed Orange Juice, Fresh Oranges, and Wiping Cloths Collected from Public Markets and Street Booths in Guadalajara, Mexico: Incidence and Comparison of Analytical Routes. *Journal of Food Protection*, **69(11)**: 2595–2599.

Ogodo, A.C., Ugbogu, O.C., Ekeleme, U.G. and Nwachukwu, N.O. (2016). Microbial Quality of Commercially Packed Fruit Juices in South-East Nigeria. *Journal of Basic applied Research*, **2(3)**: 240-245.

Nma, O. O. N., Ahaotu, I. and Ugbong, F. (2017). Isolation and Genotypic Characterization of Microbial Contaminants in Unpasteurized Fresh Juices Sold in Port Harcourt, Rivers State, Nigeria. *Journal of Microbiology Research*, **7(4)**: 99-106.

Beuchat L.R. (1996). Pathogenic microorganisms associated with fresh produce. *Journal of Food Protection*, 59:204-216

Beuchat L.R. (2002). Ecological factors influencing survival and growth of human pathogens on raw fruit and vegetables. Microbes infection, **4**:413-423.

Brayant F.H. (2007). Diseases transmitted by foods contaminated by waste water. African Journal of Food Protection, **43**:45-46.