

Journal of Plant Development Sciences

(An International Monthly Peer Reviewed Journal)

Volume 13

Number 4

April 2021

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NANO-FERTILIZERS A TECHNOLOGY TO INCREASE CROP PRODUCTION

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Received-01.04.2021, Revised-17.04.2021, Accepted-26.04.2021

Abstract: Recently the Nano-fertilizers are getting importance in sustainable agriculture in increasing crop production, enhancing nutrient use efficiency and reduction in wastage of chemical fertilizers and cost of cultivation. The new developments on application of nano-fertilizer in agriculture, plant mineral nutrition, soil health, and interactions with soil microorganism directed to sustainable way by replacing conventional fertilizers with their nano-particulate counterparts possessing superior properties to overcome the current challenges of availability and uptake of nutrients, increasing crop yield and protecting the environment. Nano-fertilizers are very effective tool for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period. Several studies showed that nano-particles of essential minerals and non-essential elements affected plant growth, physiology and development, depending on their size, composition, concentration, and mode of application, Nano-fertilizers provide more surface area for different metabolic reactions in the plant system which increase rate of photosynthesis and produce more dry matter and yield of the crop. Nano-fertilizers are applied either to soil and / or leaves. Foliar application can be done during unfavorable soil and weather conditions. In addition to this, it promotes the direct entry of nutrients into the plant system, foliar application of nano fertilizer leads to higher nutrient use efficiency (NUE) and has given a rapid response to the growth of crops. Nano fertilizers are more reactive and can penetrate through cuticle, ensuring controlled release and targeted delivery. Hence, nanotechnology has a high potential for achieving sustainable agriculture, especially in developing countries.

Keywords: Crop, Nano-Fertilizers, Production, Technology

EFFECT OF MICRONUTRIENT FERTILIZERS APPLICATION ON CROP YIELD AND NUTRIENT CONCENTRATION IN GRAIN

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Received-05.04.2021, Revised-16.04.2021, Accepted-24.04.2021

Abstract: Micronutrients play very specific role like other essential nutrient elements in the plants. Deficiency of these nutrient elements can't be rectified by the application of other nutrient elements. There is a mining of micronutrients in upper fertile soil from agriculture fields. It is due to adoption of high yielding varieties, use of micronutrient free high analysis fertilizers, less use of manures, unbalanced fertilizer use etc. Deficiency of micronutrients such as zinc (Zn), manganese (Mn) and iron (Fe) is a worldwide nutritional constraint in crop production. Many approaches have been elected to boost the Zn and Fe content in crops and ameliorate their malnutrition, including breeding, genetic engineering, and agronomic approaches. In the present review of studies it is concluded that micronutrient application through foliar treatment performs better than other application methods. Application of combined soil + foliar application of micronutrient fertilizer significantly increased the grain micronutrient content as compared to other treatments.

Keywords: Crop, Grain, Fertilizers, Malnutrition, Micronutrient

CHARACTERIZATION OF ROOT SYSTEM ARCHITECTURE UNDER ARSENIC AND CADMIUM STRESSES IN RICE

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Received-04.04.2021, Revised-20.04.2021, Accepted-28.04.2021

Abstract: Rice is major food crop for the world. Arsenic (As) cadmium (Cd) are the major heavy metal pollutant present in soil and water that disturb physiological and metabolic process of the plant cell and reduces the plant growth and yield. We have evaluated the effect of these two heavy metals on root system architecture in basmati and non-basmati (IR-64) rice genotypes. Both the variety showed significant increase in root length and number of lateral roots in MS medium at variable concentration (20, 40 and 60 μ M) of As and Cd stresses, similarly root fresh weight, root dry weight and root length was found to be increased in soil medium under both the stresses condition. There was no significant difference was observed between IR-64 and Pusa basmati in root growth parameters.

Keywords: Arsenic, Cadmium, Heavy metal stress, Root system architecture

IMPACT OF RICE RESIDUE MANAGEMENT OPTIONS AND FERTILIZERS ON YIELD AND YIELD ATTRIBUTES OF WHEAT (*TRITICUM AESTIVUM* L.)

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Received-02.04.2021, Revised-15.04.2021, Accepted-24.04.2021

Abstract: A field experiment was conducted at research farm, KVK, Panipat, CCS Haryana Agricultural University, Hisar during the *rabi* season 2018-19 and 2019-20 with the objective to study the impact of rice residue management options and fertilizer doses on productivity of wheat. The treatments applied to wheat consist of four rice residue management practices (R₁: Residue removal, R₂: Residue Burning, R₃: Residue Incorporation and R₄: Residue Retention and direct seeding of wheat with happy seeder into standing rice stubbles) in main plot and different doses of NPK fertilizers (F₁: Control, F₂:100% N + 50% Recommended dose of P&K, F₃:100% N + 75% RD of P&K, F₄: 100% N 75% RDF+ Waste decomposer and F₅:100% Recommended dose of NPK fertilizer) in sub main plot. The grain and straw yield of wheat follow the trend: Removal>Retention>Burning>Incorporation during 2018-19 and Retention>Burning>Removal>Incorporation during 2019-20. The growth, yield and yield attributes of wheat (*viz.* number of tillers/row length, grains per spike) was observed significantly higher under residue removal and 100% NPK fertiliser doses treatment during 2018-19 and under residue retention and 100% NPK fertiliser doses treatment during 2019-20. However test weight of grains was recorded higher under the retention treatment during both the years of study. There was no saving of fertilizers with residue management practices; however under burning condition, the wheat yield observed under 100 % RDF was statistically at par with 75% PK + 100% N treatment. Retention of rice straw and wheat sowing with happy seeder can be a better option for rice straw management under rice –wheat cropping system.

Keywords: Wheat, Residue management, Yield attributes

IMPACT OF LONG TERM FYM APPLICATION ON MICRONUTRIENT STATUS OF SOIL AFTER 52 YEARS OF EXPERIMENTATION

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Received-25.03.2021, Revised-13.04.2021, Accepted-20.04.2021

Abstract: Soil organic carbon plays an important role in improving physical, chemical and biological properties of soil. With the application of organic material reduction of free micronutrient cation concentration in soil solution occurs due to formation of organometallic complexes which enhance phyto-availability, and control mobility of micronutrients in the soil profile. This study was conducted with the objective to see the effect of long term application of farm yard manure (FYM) on DTPA extractable micronutrients in soil having varying levels of organic carbon content. A long term experiment was initiated in 1967 at the experimental farm of Department of Soil Science, CCS Haryana Agricultural University, Hisar India, consisting of 3 levels of FYM (15, 30 and 45 Mg ha⁻¹ till 2007-08) and 5, 10 and 15 Mg ha⁻¹ from 2008-09 onwards. A control without FYM was maintained. The treatments which show wide difference in organic carbon content after 52 years were selected T1 (FYM₀ t + N₀ kg/ha), T2 (FYM₅ t + N₀ kg/ha), T3 (FYM₅ t + N₁₂₀ kg/ha), T4 (FYM₁₅ t + N₀ kg/ha), T5 (FYM₁₀ t + N₁₂₀ kg/ha) and T6 (FYM₁₅ t + N₁₂₀ kg/ha). Organic carbon content of selected treatments were 0.49, 0.95, 1.40, 1.62, 1.78 and 1.96%. From the study it was observed that DTPA extractable Zn, Fe and Cu increased significantly with increasing content of organic carbon in all the soils and their concentration in soil varied from 0.96 to 1.14, 0.84 to 2.51, 4.04 to 6.4 and 0.96 to 1.26 mg kg⁻¹ respectively. DTPA extractable Mn also increased numerically in all soil but the effect on DTPA extractable Mn was not found significant.

Keywords: Micronutrients, Organic carbon, Long term FYM, DTPA extractable micronutrients

SITE SELECTION FOR WATER HARVESTING STRUCTURES IN ANAIYUR CATCHMENT USING WEIGHTED OVERLAY ANALYSIS

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Received-03.04.2021, Revised-18.04.2021, Accepted-22.04.2021

Abstract: Harvested rainwater is an alternative source of water in arid and semi-arid regions around the world. The present study aims to identify suitable sites for water harvesting structures in Anaiyur catchment, Kamuthy block, Ramanathapuram district by using Geographic Information System (GIS) and weighted overlay analysis. It help the decision makers in determining suitable sites for water harvesting structures based on slope, drainage network and stream order of the study area. Produced suitability site map will help in the site selection of harvesting structures such as percolation tanks, storage tank, and check dams.

Keywords: Rainwater harvesting, Site Selection, Weighted Overlay Analysis

EFFECT OF NITROGEN AND POTASSIUM FERTIGATION SCHEDULES IN RABI SUNFLOWER ON PLANT GROWTH PARAMETERS

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Received-06.04.2021, Revised-19.04.2021, Accepted-28.04.2021

Abstract: A field experiment was conducted at Water Technology Centre, College farm, Rajendranagar, Hyderabad with sunflower (variety DRSH-1) during *rabi* 2017-18 in a randomized block design with three replications and the treatments were nine with combinations of N (75 kg ha⁻¹) and K (30 kg ha⁻¹) fertilizers applied by fertigation through ventury at different intervals *viz.*, 3 days and 4 days. Drip irrigation was scheduled once in 2 days at 0.8 E pan. Fertigation was imposed at 16 DAS to 88 DAS and completed in 19 and 10 splits in 4 and 8 days interval respectively. The source of N and K fertilizers was urea and potassium sulphate respectively. The soil was sandy clay loam in texture, alkaline in reaction, non saline, low in available nitrogen, medium in available phosphorus and potassium. The amount of total irrigation water applied was 3188 m³ and 4666 m³ in drip irrigation and furrow irrigation treatments, respectively. The N and K fertigation (75-30 kg N-K₂O ha⁻¹) at 4 days interval has recorded relatively higher plant growth parameters like number of leaves plant⁻¹ (25.5), plant height (208 cm), SPAD Chlorophyll Meter Reading (55.7), leaf area index (3.5) and dry matter (158.1 g m⁻²) which were on par with N and K at 8 days interval.

Keywords: Sun flower, N &K Fertigation schedule, Growth parameters, SPAD, LAI

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GENETIC DIVERGENCE ANALYSIS IN PLANT AND RATOON OF SUGARCANE (*SACCHARUM OFFICINARUM* L.) TO ASSESS THE POTENTIAL OF GENOTYPES UNDER DIFFERENT TIME OF SOWING AND HARVESTING SCHEDULE

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Received-07.01.2021, Revised-20.02.2021, Accepted-05.03.2021

Abstract: The twenty genotypes of sugarcane (*Saccharum officinarum*) were sown on two different dates and harvested at two stages thus comprising four environment for each plant cane and its ratoon crop. The objective of the study was to assess the genetic divergence among these clones based on five quantitative and five qualitative traits under different environments. The cane height, Stalk girth, numbers of millable cane, stalk weight and cane yield were major contributors ranging from 15.29 % to 10.98 % towards the total divergence where as the quality traits brix, CCS percent, sugar recovery, sucrose percent and CCS-yield in t/ha were minor contributors varying from 8.21 % to 5.29 % in both crops. The genotypes were grouped into five clusters in all environments with varying numbers of genotypes. The low intra-cluster distance is recorded from 0 to 1.76 in the cluster of all environments indicated the closeness of the clones that cannot be used as parents in the breeding program of hybridization. The genotypes environment interaction leads to different composition of cluster and consequently the genotypes which exhibit divergence in one environment may exhibit lack of divergence in the other. Therefore, the E₂ environment of plant cane sown in March and harvested at 12 months and E₁ ratoon of March sown plant cane and harvested at 10 month work considered suitable to work out the genetic divergence due to maximum expression of genotypes for cane yield and sugar recovery. In E₂ environment of plant cane the cluster I was largest comprised of seven genotype and cluster III was smallest comprising of two genotypes whereas in E₁ ratoon the cluster III was largest comprising of eight genotypes and cluster IV comprising soliditary genotypes. In E₂ plant cane the cluster III and IV were found desirable for cane yield and cluster V for high sugar. Hence the genotypes should be selected for breeding purpose either from cluster II and IV from cluster III and V due to their higher intra-cluster distances. In E₁ ratoon the cluster II, IV and V were found desirable for cane yield and accordingly the selection of genotypes should be done either from cluster III and IV or from cluster I and II or from cluster II and V for involving them in the breeding program due to their more inter cluster distances. The critical analysis of clustering pattern and the characteristics of clusters in different environment of both crop the genotypes CoS-8436, CoS-91269, Co-1148, CoS-8432, CoLK-8102, CoJ-83, CoS-767, CoS-88216, CoS-86218 and CoS-88230 have been identified desirable for high cane yield or sugar or for both and found consistently exhibiting divergence with their corresponding genotypes.

Keywords: Cane yield, Genetic divergence, Genotype, Ratoon, *Saccharum officinarum*

EFFECT OF DIFFERENT FERTILITY LEVELS AND ROW SPACING ON GROWTH CHARACTERS OF KALMEGH

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Received-03.04.2021, Revised-15.04.2021, Accepted-26.04.2021

Abstract: A field experiment was conducted during *kharif* season 2018-19 at Soil Conservation and Water Management farm of C. S. Azad University of Agriculture and Technology, Kanpur. The experiment was laid out in factorial randomized block design with 3 replications. Different fertilizer doses were given according to treatment i.e. F₁ (30:15), F₂ (60:30), F₃ (90:45), crop was transplanted by hand in the field according to the treatment. Plant to plant spacing was maintained as 20 cm, and row to row spacing was set as 30, 40 and 50 cm accordingly. Among the following treatment with fertilizer dose given as 90 kg N + 45kg P₂O₅ ha⁻¹ (F₃) in combination with 40 cm row spacing (S₂) recorded highest growth and was significantly superior over all other treatments.

Keywords: Ayurvedic, Growth, Kalmegh, Medicinal crop

EFFECT OF MICRONUTRIENTS AND PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF GUAVA (*PSIDIUM GUAJAVA* L.) IN RAJASTHAN

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Received-06.03.2021, Revised-14.03.2021, Accepted-26.03.2021

Abstract: The field experiment was conducted at IHITC, Jaipur during the year 2018-19 and 2019-20. The experiment consisted of foliar spray of 24 treatment combinations comprising two levels each of Zn, B and Fe (0.2 and 0.4%) and two levels of NAA (50 and 100ppm) and CCC (500 and 1000ppm). Treatments were applied on foliage as foliar spray twice, 15 days before flowering and 20 days after fruit set at marble stage. This experiment was evaluated under Factorial Randomized Block Design with three replications. The results revealed that increasing levels of micronutrients (Zn, B and Fe) and PGRs (NAA and CCC) significantly increased the growth (gain in plant height and spread NS & EW), yield (per tree and per hectare). Interactions of 0.4% H₃BO₃ and 100ppm NAA gave best results in respect to growth and yield.

Keywords: Growth, Yield, Micronutrients, Plant growth regulators

INFLUENCE OF DIFFERENT DATE OF PLANTING OF RICE ON YIELD AND CROP PRODUCTIVITY IN VERTISOLS

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Received-05.04.2021, Revised-18.04.2021, Accepted-27.04.2021

Abstract: The nutrient management practices were also influenced due to variable climatic conditions during the crop growth period and nutrients availability was influenced through soil plant atmosphere continuum which in turn resulted in higher rice yields due to variable treatments. The nutrient management practices influenced the growth and yield of rice and highest grain yield of rice (38.78 q/ha) was recorded with T5 (100%NPK+ Zn+ S +GM @6 t/ha+ FYM @3 t/ha +Straw@3 t/ha as mulch +1% Fe + 0.2% B spray) treatment. The major and micronutrient content in grain and straw was also influenced significantly due to application of organics and fertilizers and higher contents were recorded T5 (100%NPK+Zn+S+GM @6 t/ha+ FYM @3 t/ha +Straw@3 t/ha as mulch +1% Fe + 0.2% B spray) and, T4 (150% NPK + Zn + S + 1% Fe + 0.2% B spray) treatments.

Keywords: Crop, Growth, Yield, Productivity, Rice

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EFFECT OF MOISTURE REGIMES AND INTEGRATED NITROGEN MANAGEMENT ON GROWTH CHARACTERS OF POTATO (*SOLANUM TUBEROSUM* L.)

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Received-09.04.2021, Revised-21.04.2021, Accepted-28.04.2021

Abstract: A field experiment was conducted to study the effect of moisture regimes and integrated nitrogen management on the performance of potato crop (*Solanum tuberosum* L.) during Rabi season of 2016-17 at Agronomy Research Farm, Narendra Deva University of Agriculture & Technology (Narendra Nagar), Kumarganj, Faizabad (UP). The treatments included to irrigation methods viz. M₁ (Regular furrow irrigation method) and M₂ (alternate furrow irrigation method), moisture regime viz. 0.8 IW/CPE, 1.0 IW/CPE and 1.2 IW/CPE with 6 cm irrigation water depth and nitrogen management viz. N₁ (100% dose of N through urea), N₂ (75% dose of N through urea + 25% dose of N through compost) and N₃ (50% dose of N through urea + 50% dose of N through compost). The experiment was laid out in Split Plot Design with four replications. The soil of experimental field was silt loam in texture, poor in organic carbon and nitrogen, medium in available phosphorus and rich in potassium with pH 8.0. The planting was done by hand on ridges and nutrients and irrigations were applied as per treatment. Initial plant stand was non-significant under various irrigation methods, moisture regimes and nitrogen management. The growth characters viz. plant height, number of haulms at 30 DAP was also insignificant but at 60 and 90 DAP, there were significantly superior under M₁ (regular furrow irrigation method) with I₂ (1.0 IW/CPE) and N₂ (75% dose of N through urea + 25% dose of N through compost). Number of all grade of tubers was found to be significant due to effect of moisture regimes.

Keywords: Furrow irrigation, Split plot design, Moisture regimes, Irrigation water

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CORRELATION AND PATH ANALYSIS STUDIES IN FORAGE SORGHUM

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Received-11.01.2021, Revised-26.02.2021, Accepted-10.03.2021

Abstract: Analysis of variance for all the characters viz., days to 50% flowering, plant height, leaf breadth, leaf length, leaf area, stem girth, leaves per plant, leaf stem ratio, total soluble solids and green fodder yield, revealed significantly high variation, indicating that presence of great deal of diversity among the parents with respect to fodder yield and yield contributing attributes. Genotypic and phenotypic coefficient of variation was found high (more than 25%) for leaves per plant, leaf stem ratio and green fodder yield, which indicated that more variability and scope for selection in improving these traits. High heritability coupled with high genetic advance as percent of mean was recorded for plant height, leaf area, stem girth, leaves per plant, leaf stem ratio, total soluble solids and green fodder yield per plant which indicated that these traits were highly heritable and selection of high performing genotypes is possible to improve these attributes. Green fodder yield exhibited significant stable and positive correlation with stem girth, leaves per plant and leaf stem ratio at genotypic and phenotypic level. These characters may be considered as important yield component in forage sorghum. Leaf breadth displayed high order of direct effect on green fodder yield per plant followed by leaf area, plant height and leaves per plant at phenotypic and genotypic level, which indicating that the contribution of individual characters to fodder yield is of importance in planning a sound breeding programme for developing for high yielding varieties in forage sorghum.

Keywords: *Sorghum bicolor*, Variability, Correlation, Path analysis

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EFFECT OF MOISTURE CONSERVATION PRACTICES ON YIELD, QUALITY AND NUTRIENT UPTAKE OF INDIAN MUSTARD AND CHICKPEA INTERCROPPING SYSTEM UNDER RAINFED CONDITIONS

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Received-09.04.2021, Revised-20.04.2021, Accepted-27.04.2021

Abstract: A field experiment was conducted during winter season 2018-19 and 2019-20 at the Research Farm, College of Agriculture, Gwalior (M.P.) to study the effect of moisture conservation practices on Indian mustard-chickpea intercropping under rainfed conditions. The treatments comprised of four intercropping systems and four moisture conservation practices which were evaluated in randomized block design (factorial) with three replications. The results revealed that the seed and straw yield (23.05 and 24.21q/ha) were found significantly higher in case of 1:4 and 2:4 intercropping systems, respectively, followed by chickpea grown alone. The mustard grown alone produced the lowest seed (13.54 q/ha) and straw (23.32 q/ha). Straw and weed mulching brought about equally higher seed and straw yields of mustard plus chickpea. This was followed by soil mulching. The lowest yields were obtained under no mulching treatment. The M+ ch (2:4) recorded maximum oil content (41.47%) and protein content (24.37%). This was closely followed by M+ ch (1:4) treatment (39.76 and 24.06%, respectively). Sole mustard or sole chickpea recorded the lowest values. The oil yield was found significantly maximum (529.12 kg/ha) under sole cropping of mustard, followed by M + ch (2:4) i.e. 334.76 kg/ha and then M + ch (1:4) i.e.183.41kg/ha. Similarly protein yield was found significantly highest under sole cropping of chickpea (519.04 kg/ha). This was followed by M + ch(1:4) i.e. 446.09 kg/ha and then M + ch (2:4) i.e.395.55 kg/ha. Sole mustard and sole chickpea recorded significantly higher nutrient uptake. This was followed by mustard + chickpea (1:4 row ratio) and then mustard + chickpea (2:4 row ratio). Weed mulching registered maximum N, P and K uptake by grain and straw of mustard and chickpea.

Keywords: Nutrient uptake, Quality, Intercropping, Mulching, Chickpea

Journal of Plant Development Sciences Vol. 13(4)

EFFECT OF PHYSICAL AND CHEMICAL SEED TREATMENTS ON GERMINATION AND VIGOUR INDEX IN AONLA (*EMBLICA OFFICINALIS*)

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Received-05.01.2021, Revised-17.02.2021, Accepted-02.03.2021

Abstract: *Emblica officinalis* is an important medicinal plant and used as a constituent of ayurvedic and unani medicine. The seed showed dormancy and causes a big challenge in seed germination. Exogenous dormancy is observed due to non imbibitions of water by intact hard seed coat. Enhanced water imbibition rate (0.364-0.395gm/gm dry seeds/day) was observed in mechanically chipped treated seeds on 1st day soaking. The seeds taken under study were subjected to quick seed viability test (TZ) which showed 91-94% seed viability. The low value of electrical conductivity (0.219-0.230 μ mho/cm) of the seeds leachates, also indicated the high intactness of the seeds. The hot water treatment for 10 minutes recorded better germination (65-75%) as compared to the mechanical (chipping) treatment (35-40%). The chipped seeds treated with 0.5% KNO₃ was found most effective in enhancing germination percentage (95-100), vigour index and speed of germination over the GA₃ and Thiourea treatments. Thus the mechanically chipped seeds followed by imbibition of chemical (GA₃, KNO₃ and Thiourea) solution recorded synergistic action in terms of the better germination and the seedling vigour.

Keywords: *Emblica officinalis*, Dormancy, Germination, Scarification, Imbibition, Vigour index