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Role of Organic NPK Nanofertilizers on Morphological and Phenological Parameters of Chilli (*Capsicum annum* L.) under Different Nutrient Managements

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A B S T R A C T

Chilli is a very important vegetable crop and has a great demand in the processing industry and export market. Chilli crop is more responsive to fertilizer application. Application of fertilizers in excess not only causes environmental problems but also reduces nutrient use efficiency, increases the cost of production and reduces the benefit-cost ratio. Nanotechnology is a newly emerging tool for solving these problems. The investigation is on "Role of organic NPK nanofertilizers on morphological and phenological parameters of chilli (*Capsicum annum* L.) under different nutrient managements" was conducted at Regional Agricultural Research Station, Pillicode, Kerala Agricultural University from September, 2018 to February, 2019. The experiment consisted of nine treatments with three replications laid out in randomized block design. The treatments were T_1 : Control (soil test based nutrient management) ; T_2 : Organic nano NPK granules ; T_3 : T_1 + Organic nano NPK foliar @ 0.5 % ; T_4 : T_1 + NPK 19:19:19 foliar @ 0.5 % ; T_5 : T_2 + Organic nano NPK foliar @ 0.5 % ; T_6 : T_2 + NPK 19:19:19 foliar @ 0.5 % ; T_7 : Organic management (KAU POP, 2009) ; T_8 : Organic Management + organic nano NPK foliar @ 0.5 % and T_9 : Absolute control. Organic Nano NPK granules were applied as a basal dose and also as top dressing at 30 and 60 days after transplanting (DAT) @ 0.33 g / plant. Foliar spray of organic nano NPK and NPK 19:19:19 were given at 35, 65, 80 and 95 days after transplanting. Morphological and phenological observations namely plant height (cm), leaf area (cm^2) per plant, number of leaves per plant, number of branches per plant, crop duration, first harvest and 50 % flowering were recorded to be maximum in the treatment, organic nano NPK granules with NPK 19:19:19 foliar spray (T_6) followed by organic nano NPK granules with organic nano NPK foliar spray (T_5).

Keywords

Chilli crop, Organic nano fertilizer, 19:19:19 NPK, Morphological parameters, Phenological parameters

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Introduction

Chilli (*Capsicum annum* L.) is a spice crop, which is very important because of its pungency, used as green or at ripe stage. Chilli belongs to the family Solanaceae and genus *Capsicum*. Origin of chilli is southern parts of Mexico and Bolivia. Among the 400 chilli varieties seen all over the world, five important chilli species used for cultivation are *C. annum*, *C. baccatus*, *C. chinense*, *C. frutescens*, and *C. pubenscens*. Considering the usage, *C. annum* is the most important species that is widely cultivated.

Fertilizers are an essential part of nutrients which contributes potential yield and quality of the crop. After the green revolution, we achieved self sufficiency in food production but in mean time we exploited the soil health. Deficiency of nutrients adversely affects the physiological and biochemical functioning of the plant which leads to a reduction in growth and quality of the crop. Different combination of fertilizers leads to higher productivity without impairing the environment sustainability (Deepa, 2016). Therefore targeted and sufficient application of fertilizer is important for growing crops.

Conventional fertilizer generally applied as soil broadcasting or as spray, but the disadvantage is that only very less concentration reaches to plant due to loss of different nutrients by various processes, such as leaching, drift, runoff, evaporation and microbial degradation. Now a days, we use a large amount of fertilizer in order to feed large population, which is very harmful to our environment (Verma, 2017). Hence to meet the crop nutrient requirement, the optimal use of fertilizer is essential.

Nano fertilizer is new emergent fertilizer which increases yield and growth by improving the nutrient use efficiency of the crop. It also reduces the wastage of nutrient from the soil through leaching as per findings of Liu and Lal (2014). Nano fertilizer have a very small size that is less than 100 nm, which increases it penetration into plant, lead to increase the metabolic activity, yield and quality of the crop. Foliar fertilizer application increases the translocation efficiency which is more efficient than the soil application. 19:19:19 NPK is water soluble which leads to rapid crop growth and quickly eliminate the nutrient deficiency.

All these nutrient managements make the crop grow quickly and healthy which lead to reduce the pest and disease incidents. It also help to reduce the usage of insecticides and pesticides helps in uniform flowering which ultimately enhances the crop yield. Therefore, further research on the influence of soil and foliar application of organic nano NPK is proposed to explore the impact of them under various nutrient managements on morphological and phenological parameters of chilli crop.

Materials and Methods

The research work was carried out at Regional Agricultural Research Station (RARS), Pilicode, Kerala Agricultural University. The objective of the study was to investigate the influence of soil and foliar application of organic nano NPK under various nutrient managements for enhancing morphological and phenological parameters of chilli. Soil sample was collected for analysis of physical and chemical properties of the soil.

The experiment consisted of nine treatments with three replications laid out in randomized block design (RBD). The treatments were T_1 : Control (soil test based nutrient management); T_2 : Organic nano NPK granules ; T_3 : T_1 + Organic nano NPK foliar @ 0.5 % ; T_4 : T_1 + NPK 19:19:19 foliar @ 0.5 % ; T_5 : T_2 + Organic nano NPK foliar @ 0.5 % ; T_6 : T_2 +

NPK 19:19:19 foliar @ 0.5 % ; T_7 : Organic management (KAU POP, 2009) ; T_8 : Organic Management + organic nano NPK foliar @ 0.5 % and T_9 : Absolute control. Organic nano NPK granules were applied as a basal dose and also as top dressing at 30 and 60 days after transplanting @ 0.33 g/plant. Foliar spray of organic nano NPK and NPK 19:19:19 were given at 35, 65, 80 and 95 DAT.

Morphological observations namely plant height (cm), leaf area (cm^2) per plant, number of leaves per plant, number of branches per plant was measured at 45, 75, and 105 day after transplanting. Plant height was measured with scale from ground level to the tip of the fully opened leaf on the main branch. Leaf area per plant were measured from each tagged plants. The leaf was wiped out using tissue paper for removing dust particles. Leaf area was directly measured using a portable automatic leaf area meter model LI 3000 A. Number of leaves per plant were measured from each tagged plant, 20 leaves were collected and obtained the dry weight. The dry weight of all leaves of the plant was taken. The number of leaves per plant were calculated by using back calculation. Number of side branches produced from the main branch were counted from 5 representative plants of a plot and average number was taken. The observation was taken at 45, 75 and 105 days after transplanting.

The number of days taken from first flower formation to 50 % of the total number of the plants in a plot, was taken as days to 50 % flowering. When the first flower was produced, then that plant was tagged by a coloured ribbon. This tagging was continued up to 50 % of the plants produced first flowering. The days taken for first harvest from the day of transplanting were recorded. Duration of the crop was recorded from sowing to final harvest of crop as a duration of the crop. The data analysis was done using statistical package, STAR. Multiple comparisons among treatment means, where the F test was significant (at 5 % level) were done with Duncan's Multiple Range Test.

Results and Discussion

Soil characters before the experiment

Before starting the experiment, the soil of the experimental plot was analysed for its nutritional status. The data on soil characters (Table 1) revealed that soil was acidic in nature and magnesium and boron nutrients were deficient in the experiment field. So the experimental plot was applied with lime @ 350 kg per ha and for correcting magnesium and boron deficiency, $MgSO_4$ @ 80 kg per ha and Borax @ 10 kg per ha were applied to soil for correcting the soil nutrient status.

Morphological Observations

Plant height (cm) and number of branches per plant

The data on plant height and number of branches per plant at 45, 75 and 75 DAT are presented in Table 2. Plant height and number of branches per plant were significantly affected under different nutrient managements.

At 45 DAT, the maximum plant height was observed from treatment T_6. The treatment T_6 was on par with T_5. The treatment T_5 was on par with T_4, T_2 and T_1. Significantly maximum plant height was recorded by T_6 at 75 and 105 DAT followed by treatment T_5. At 105 DAT, Treatment T_5 was on par with treatments T_4, T_3 and T_2. At all three crop growth stages, the maximum and minimum plant height were recorded in treatment T_6 and T_9 respectively (Fig. 1). Organic nano NPK granules with 19:19:19 NPK foliar spray (T_6) was significantly superior to all other treatments followed by nano NPK granule application with organic nano NPK foliar spray (T_5). Plant height was significantly affected by various nutrient managements. Treatment T_6 showed 18 per cent increase in plant height compared to control. These results are in conformation with Meena *et al.*, 2017, Plant height is an important morphological parameter which is directly influenced by organic nano fertilizer. The nano fertilizer has an influence on the modification of plant gene expression and biological pathways that affect the plant height. Nano fertilizer was shown to have a direct trend in the increase in plant height in cotton (Rochester *et al.*, 2001). The foliar application of 19:19:19 NPK enhanced various physiological and metabolic activity which increased the plant height in orange (Hipps, 1997; Tredes, 2012).

At 45 DAT, the maximum number of branches per plant were recorded in treatment T_6. The treatment T_6 was on par with treatment T_5, T_4 and T_3. At 75 DAT, the maximum number of the branches per plant was recorded in T_6 which was on par with T_5, T_4 T_3 and T_2 but the lowest number of branches was recorded with T_8 which was on par with T_9 and T_1. At 105 DAT, the maximum number of branches per plant as was recorded in T_6 and which was on par with T_5 and T_4. The lowest value was observed in T_9. The nano NPK granule with 19:19:19 NPK spray (T_6) was registered maximum number of branches per plant followed by T_5 treatment. Number of branches per plant increased from the initial growth phase to the final growth phase.

Leaf area per plant (cm^2) and number of leaves per plant

The data on the number of leaves per plant and leaf area per plant are presented in Table 3. At all stages of the crop the number of leaves per plant was affected by various nutrient managements. An increasing trend was observed from 45 DAT to 105 DAT. Nano NPK granule with 19:19:19 foliar spray (T_6) was significantly superior to all other treatments at all crop stages.

At 45 DAT, significantily maximum leaf area per plant was recorded in treatment T_6 (7783 cm^2) followed by T_5. The lowest leaf area per plant recorded with T_9 (1705 cm^2). At 75 DAT, the application of nano NPK granule with 19:19:19 foliar spray (T_6) had the significantly higher of leaf area (14980) followed by T_5.

At 105 DAT, the maximum leaf area was recorded in T_6. During all three crop stages, the maximum leaf area per plant was noted in treatment T_6 followed by treatment T_5 (Fig. 2). Leaf area per plant increased from 45 (DAT) to 105 DAT. Nano NPK granules with 19:19:19 NPK foliar spray (T_6) was significantly superior to all other treatments followed by nano NPK granule application with nano NPK foliar spray (T_5). This result is in conformity with Sabir *et al.*, (2014) where increase in the absorption of nitrogen by using nanofertilizer.

At 45 DAT, the maximum number of leaves per plant was observed in obtained at 181.50 followed by T_5 and T_3. The lowest value was recorded in absolute control which was on par with T_7. At 75 DAT, all the treatments significantly differed with each other. The maximum number of leaves per plant was recorded in T_6 followed by T_4, T_3,T_5, T_2 and $T_{1.}$ At 105 DAT, the maximum number of leaves per plant was recorded in T_6 followed by T_4, T_3 and T_5 treatments.

NPK fertilizer enhanced the vegetative growth which leds to an increase in the leaf area per plant. Increase leaf area per plant was due to the availability of NPK at a critical stages and more concentration in carrot (Naik *et al.*, 2002).

Table.1 Soil characters before the experiment

Parameters	Quality	Remarks
pH	4.9	Acidic
Electrical conductivity (dS/m)	0.17	Normal
Organic carbon (%)	1.4	High
Available nitrogen (kg /ha)	290.7	Medium
Available phosphorous (kg /ha)	44.1	High
Available potassium (kg /ha)	445.5	High
Available sulphur (mg /kg)	55.1	Sufficient
Available calcium (mg /kg)	400	Sufficient
Available magnesium (mg /kg)	60	Deficient
Micronutrients		
Copper (mg /kg)	1.13	Sufficient
Iron (mg /kg)	60	Sufficient
Zinc (mg /kg)	7.37	Sufficient
Manganese (mg /kg)	37.3	Sufficient
Boron (mg /kg)	0.24	Deficient

Table.2 Effect of various nutrient managements on the plant height (cm) and number of branches per plant

Treatments	**Plant height (cm)**			**Number of branches/ plant**		
	45 DAT	75 DAT	105 DAT	45 DAT	75 DAT	105 DAT
T_1	52.0^{bcd}	73.8^{b}	81.0^{cd}	7^{bc}	29^{cd}	33^{c}
T_2	56.0^{bc}	74.0^{b}	82.8^{bcd}	8^{bc}	33^{abc}	36^{c}
T_3	50.0^{cd}	74.9^{b}	84.0^{bcd}	10^{ab}	34^{abc}	45^{b}
T_4	54.0^{bcd}	75.3^{b}	86.3^{bc}	12^{ab}	35^{abc}	48^{ab}
T_5	59.0^{ab}	78.0^{b}	88.7^{b}	12^{ab}	37^{ab}	49^{ab}
T_6	66.0^{a}	89.0^{a}	95.0^{a}	15^{a}	40^{a}	52^{a}
T_7	51.3^{cd}	69.9^{bc}	79.0^{d}	7^{bc}	20^{d}	23^{d}
T_8	53.0^{bcd}	73.0^{bc}	81.0^{cd}	7^{bc}	23^{d}	26^{d}
T_9	48.2^{d}	65.0^{c}	72.0^{e}	4^{c}	11^{ecd}	15^{e}
CD (0.05)	7.0	8.3	6.2	5.5	7.6	6.3

Table.3 Effect of various nutrient managements on leaf area per plant and number of leaves per plant

Treatments	**Leaf area per plant (cm^2)**			**Number of leaves per plant**		
	45 DAT	75 DAT	105 DAT	45 DAT	75 DAT	105 DAT
T_1	2970^{f}	9716^{e}	11089^{e}	99.00^{de}	347.00^{d}	515.00^{f}
T_2	3998^{e}	8153^{f}	10054^{f}	105.50^{d}	354.50^{d}	538.00^{e}
T_3	4310^{d}	11295^{c}	12399^{c}	126.66^{c}	376.50^{c}	589.00^{c}
T_4	4410^{c}	10660^{d}	11399^{d}	131.66^{bc}	410.00^{b}	634.00^{b}
T_5	5754^{b}	11360^{b}	12980^{b}	137.50^{b}	355.00^{d}	548.00^{d}
T_6	7783^{a}	14980^{a}	16786^{a}	181.50^{a}	428.00^{a}	699.00^{a}
T_7	2106^{h}	5592^{h}	7989^{h}	81.00^{fg}	233.50^{f}	415.00^{h}
T_8	2517^{g}	7025^{g}	8594^{g}	90.00^{ef}	281.00^{e}	498.00^{g}
T_9	1705^{i}	4203^{i}	6955^{i}	77.50^{g}	186.00^{g}	379.00^{i}
CD (0.05)	25.0	30.0	15.0	10.56	11.34	9.16

Table.4 Effect of various nutrient managements on days to 50 % flowering, days to the first harvest and duration of crop

Treatments	Days to 50 % flowering flowering	Days to first harvest the first harvest	Duration of crop
T_1	61^{bc}	105^{ab}	189^{ef}
T_2	58^{cd}	99^{bc}	196^{de}
T_3	52^{de}	95^{cd}	212^{bc}
T_4	54^{cd}	89^{cd}	204^{cd}
T_5	50^{de}	85^{de}	228^{a}
T_6	45^{e}	85^{e}	216^{b}
T_7	67^{ab}	105^{a}	150^{g}
T_8	63^{ab}	102^{ab}	182^{f}
T_9	73^{a}	108^{a}	127^{h}
CD (0.05)	8.17	5.36	11.83

Fig.1 Effect of nutrient managements on plant height (cm)

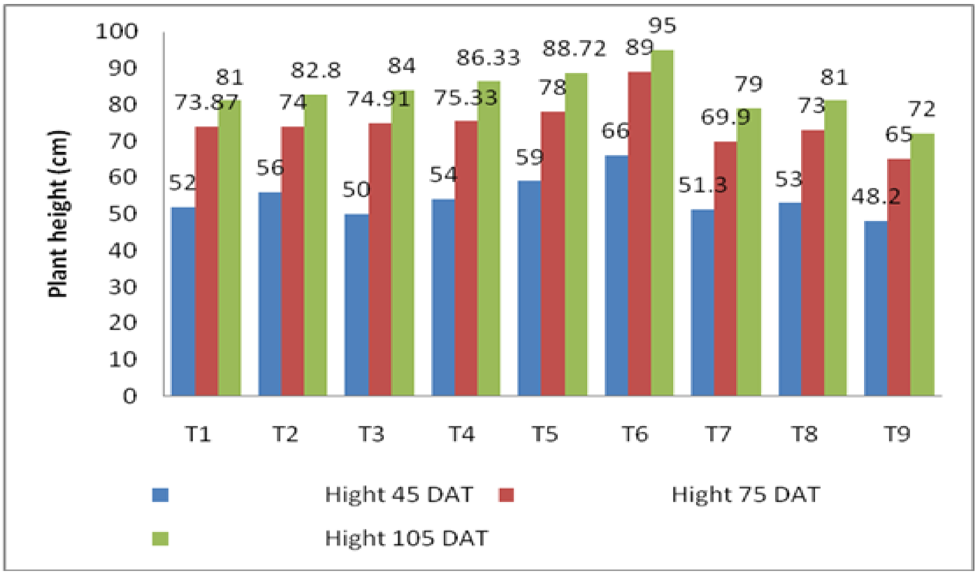


Fig.2 Effect of nutrient managements on leaf area per plant

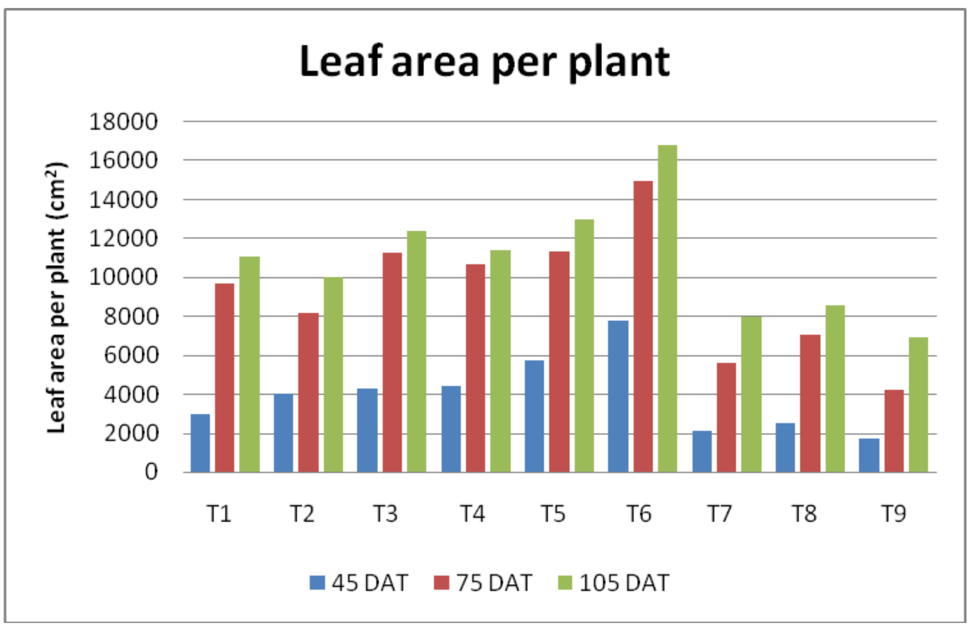


Fig.3 Effect of treatments on the number of leaves per plant

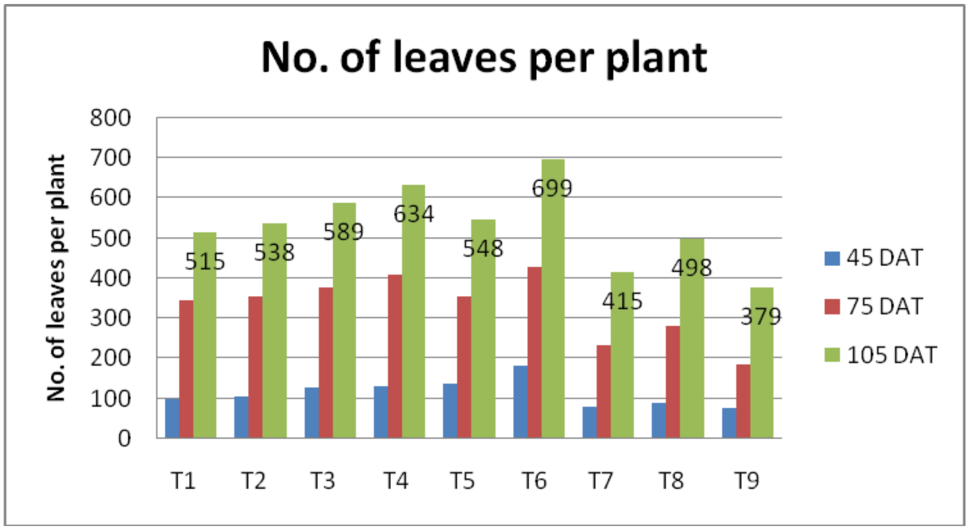


Fig.4 Effect of nutrient managements on days to 50 % flowering

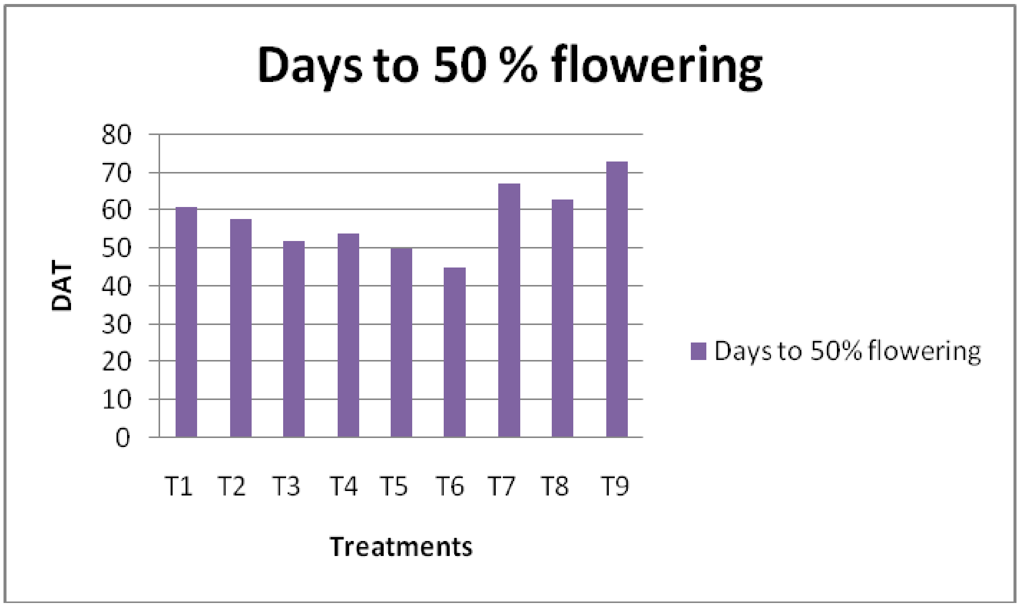
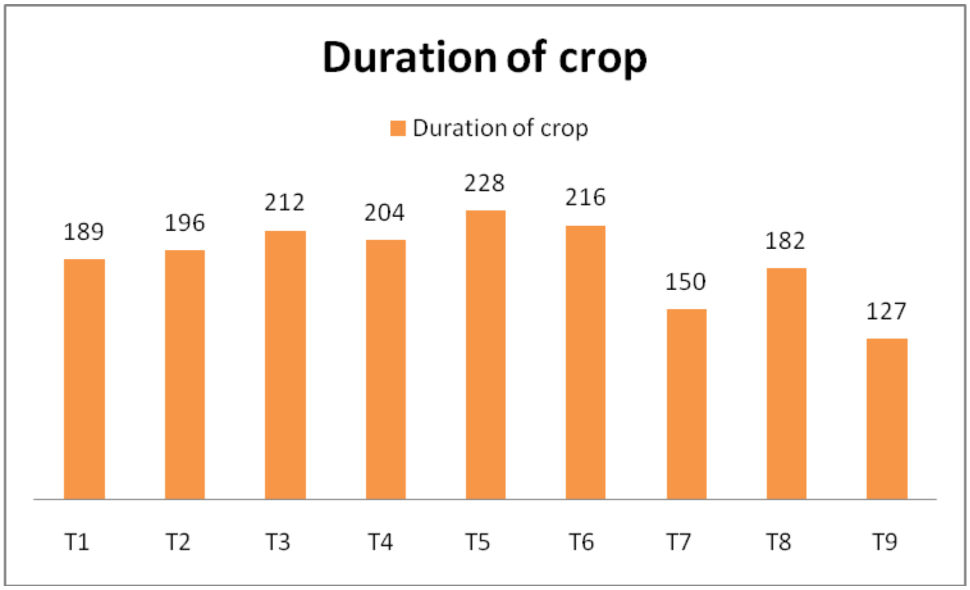


Fig.5 Effect of nutrient managements on the duration of crop



In all growth periods, the maximum and the minimum number of leaves per plant was recorded in T_6 and T_9 respectively (Fig. 3), also an increasing trend was observed from the initial stage to the final stage of the crop growth. Nano NPK granule with 19:19:19 foliar spray (T_6) was significantly superior to control in all crop stages. Similar results are also noticed by Sabir *et al.,* (2014).

Days to 50 % flowering, days to first harvest and duration of the crop

The data on days to 50 % flowering, days to first harvest and duration of crop is presented in Table 4.

The treatment T_6 recorded least number of days to 50 % flowering (45 days) followed by T_5 (50 days) for 50 % flowering. In treatment. While it took 73 days for attaining 50 % flowering in absolute control (T_9). T_5 and T_3 treatments with nano NPK foliar application had recorded early flowering which was on par with T_6. Nano NPK granule with 19:19:19 NPK spray (T_6) first attained 50 % flowering which had taken only 45 days for attaining 50 % flowering followed by treatment T_5 (50 days).

Similar results were also noticed by Tredes (2012) in wheat application of nano fertilizer enhanced physiological and metabolic activity and also changed the gene expression which led the transition from vegetative to floral characters.

The days to the first harvest significantly differed among all the treatments. The different fertilizer managements had an influence on days to the first harvest of the crop. The minimum days taken for the first harvest were recorded in the treatment T_6 and T_5. The maximum number of days taken for the first harvest of the crop was T_9 (absolute control) which was on par with T_1, T_7 and T_8.

Minimum number of days for the first harvest was required in the treatment, T_6 which was significantly superior to other treatments followed by T_5 (Fig. 4). So nano NPK granule with 19:19:19 NPK foliar spray influenced early harvest of the crop. Similar results were also noticed by Liu and Lal, 2014 in cabbage, tomato and egg plant indicated that the nano fertilizer had a role in the early harvest of the vegetables that comes to the market 5 to 7 days ahead.

The foliar application of nano NPK enhanced the earliness of harvest in sunflower (Savan *et al.,* 2018). Nano granules with foliar application of 19:19:19 NPK spray helped for early harvest, this might be due to the effect of phosphorous which led to enhance the maturity in rice (Bhowmick *et al.,* 2014).

Different nutrient managements were significantly different from each other on the duration of the crop. The various fertilizer managements affected the duration of the crop.

The significantly maximum duration (228 days) of the crop was recorded in treatment T_5 followed by treatment T_6 (216 days). The lowest crop duration was noted in absolute control (T_9). So the nano NPK granule with nano NPK foliar spray (T_5) significantly affected the duration of the crop and hence treatment T_5 was significantly superior to all other treatments.

The maximum duration of the crop was recorded in treatment T_5 followed by T_6. So the nano NPK granule with nano NPK foliar spray (T_5) significantly enhanced the duration of the crop (Fig.5).

Similar result was also noticed by Subramanian and Rahale (2000), nano NPK fertilizer is slow releasing fertilizer. Nano fertilizer release nitrate form of nitrogen 50 days slower than conventional fertilizer. Increased nitrogen application enhances the vegetative growth which increases the duration of the black gram crop (Kumar and Ratna, 2003). Bhowmick *et al.,* 2014 also reported that the nano foliar application has an impact on physiological activities which reduced the leaf senescence and improved the growth duration of the rice crop.

References

Bhowmick, M. K., Dhara, M. C., Duary, B., Biswas, P. K., and Bhattacharyya, P. 2014. Improvement of lathyrus productivity through seed priming and foliar nutrition under rice-utera system. *J. Crop Weed*. 10: 277-280.

Deepa, N.D. 2016. Responds of vegetable crops to foliar feeding of water soluble fertilizer. *Asian J. Hortic*. *11*(1): 242-251.

Hipps, N. A. 1997. Effect of nitrogen, phosphorous, water and preplanting soil sterilization on growth and yield of Cox Orange and M9 apple trees. *Acta Hortic*. 44(8): 125–131.

Kumar, J. and Rana, P. 2003. Response of nitrogen and IAA in spray carnation. *J. Ornamental Hortic*. 6(3): 285–286.

Liu, R. and Lal, R. 2014. Synthetic apatite nanoparticles as a phosphorus fertilizer for soybean (Glycine max). *Scientific Reports*. 4(1): 56-86.

Meena D. S., Gautam C., Patidar O., P., Meena H. M., Prakasha G., and Vishwa J. 2017. NanoFertilizers are a new way to increase nutrients use efficiency in crop production. *Inter. J. Agri. Sci.* 7(9): 3831-3833.

Naik, L. B., Prabhakar, M., and Tiwari, R. B. 2002. Influence of foliar sprays with water soluble fertilizers on yield and quality of Carrot (Daucus carota L). Proc, Int. Conf. Vegetables, Bangalore. P:183.

Rochester I.J., Peoples M.B., Hulugalle R.R. and Constable G. A. 2001. Using legumes to enhance nitrogen fertility and improve soil condition in cotton cropping systems. Field Crops Res. 70(1): 27-41.

Sabir, S., Arshad, M., and Chaudhari, S.K. 2014. Zinc oxide nanoparticles for revolutionizing agriculture: synthesis and applications. *Sci. World J.* 2(3): 116-122

Savan, R.A., Dey, P., and Babu, A. 2018. *Effects of supplementary foliar application of nitrogen and potassium on drought tolerance of sunflower (Helianthus annuus L.)* (Doctoral dissertation, University of Agriculture Faisalabad Pakistan).

Subramanian, K. S. and Sharmil Rahale, C. 2009. Nano-fertilizer formulations for balanced fertilization of crops. Platinum Jubilee Celebrations of ISSS,

Tredes, N. 2012. African agriculture: Dirt poor. *Nature News*, *483*(7391), p.525.

Verma, R. 2017. Efficient fertilizer use: The key to food security and better environment. *J. Trop. Agric.* 47(1): 1-17.

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