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Effect of integrated nutrient management on plant growth, fruit yield and quality of phalsa (*Grewia subinaequalis* D.C.)

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ABSTRACT : Field experiment was carried out to ascertain the effect of integrated nutrient management on plant growth, fruit yield and quality of phalsa. Eleven treatment combinations of nutrient resources were tested on phalsa var. Sharbati. The maximum plant growth and fruit yield (5.06 kg per plant and 5.23 kg per plant) in both the year, respectively was obtained with treatment T_6 closely followed by treatment T_7. The physical character of fruits *viz*., fruit length (1.13 and 1.15 cm), fruit breadth (1.37 and 1.35 cm), weight of fifty fruits (38.63 and 39.10g) and juice per cent (51.11 and 51.92%) and pulp/stone ratio (1.60 and 1.62) were recorded maximum with treatment T_6 during both the years, respectively. Chemical character of fruit *viz*., TSS (27.64 and 27.91%), reducing sugars (19.38 and 19.40%), non reducing sugars (2.37 and 2.38%) and total sugars (21.74 and 21.78) were obtained with treatment T_6 during both the years, respectively. The minimum acidity (2.24 and 2.20%) and maximum ascorbic acid (38.51 and 38.21 mg/100 ml juice) was also obtained with treatment T_6 during both the years respectively. On the basis of performance treatment T_6 FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $ZnSO_4$(0.4%) may be applied for better growth, yield, quality and sustainability of phalsa crops.

KEY WORDS : Phalsa, Bio-fertilizers, Nutrients, Micronutrients

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Use of chemical pesticides and fertilizers not only extensively damage the beneficial microbes in the soil but also cause ill effects on human health as well as environment hazards and reduce soil fertility (Macid *et al*., 2007). The new approach to farming often referred to as sustainable agriculture, seeks to introduce agricultural practices that are ecofriendly and maintained the long term ecological balance of the soil ecosystem. The judicial use of beneficial microbial inoculants (biofertilizers) along with organic manure is considered as the alternative source to meet the nutrient requirement of crop.

Phalsa (*Grewia subinaequalis* D.C.) is subtropical fruit and has high nutrition value containing iron, vitamin A and C. Its fruits possess high medicinal properties. It is a crop of arid and semi arid regions because of its hardy nature. It comes under minor fruit crops but it is a valuable fruit. Because of these, phalsa produces often use very large amounts of synthetic mineral nutrients which is not sustainable due to ill effects on soil and environment *vis.*, a *vis*., much involvement of non renewable energy in production input used, attempt to improve yield and quality of crop. Keeping in view the above facts, the present experiments was conducted to study the effect of integrated nutrient management on plant growth, fruit yield, quality of fruits and phalsa production.

RESEARCH METHODS

The experiment was carried out at main experiment station, department of horticulture, Narendra Deva University of Agriculturte and Technology, Kumarganj, Faizabad (U.P.) for two consecutive years (2007-08 and 2008-09). Cultivar Sharbati was used to evaluate the influence of eleven treatments comprising different combinations of nutrient resources. The nutrient composition of was FYM with 1 per cent N_2O, 0.5 per cent P_2O_5 and 1 per cent K_2O. The amount of

respective nutrient resources was calibrated on basis of different doses *viz*., 100 per cent NPK, 75 per cent NPK and 50 per cent NPK. The experiment was laid out in Randomized Block Design with three replications in the month of January, 2008. Two plants were taken as unit per plot. Fifteen year old uniform phalsa plants, planted at 3x2 m apart were taken. The recommended dose of fertilizers (100g N, 125g P, 100g K per plant) and dose of FYM was 15 kg per plant.

For estimating the yield and quality characters of the phalsa fruits was done just after the picking of the fruits in the second fort night of May.

RESEARCH FINDINGS AND DISCUSSION

Different treatment combinations of nutrient resources influenced the plant growth, fruit yield and quality significantly (Table 1). Treatment T_6 FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $ZnSO_4$(0.4%) recorded highest length of shoots, number of shoots per plant, number of leaves per shoots, intermodal length and pruned wood weight per plant. The maximum shoot length was recorded with application of same treatment during both the years, respectively (2.65 and2.68cm). this treatment was also effective for number of shoots per plant (117.33 and 118.67). These results are in conformity with the findings of Bopaiah and Khader (1989). Rani and Sathimoorthy (1997) have also reported an increase in plant height and growth enhancement of black pepper and papaya, respectively with the application of biofertilizers. The maximum number of leaves and intermodal length was obtained with T_6 and closely followed T_7 [FYM +75 % NPK+ *Azotobacter*+ PSB+ $FeSO_4$ (0.4%)] Yadav *et al*. (2008), also reported better vegetative growth with FYM + NPK+ biofertilizers in phalsa crops.

Available results showed (Table 2) the maximum number of fruits (15.93 and 16.23) and number of fruiting nodes (25.12 and 24.76) was recorded with the application of T6 followed by T_7. All the treatments significantly increased the number of fruiting node per shoot in comparison to T_1 (FYM+ 100 % NPK). The maximum fruit yield was recorded during both the years (5.06 and 5.23 kg per plant, respectively) and juice per cent and pulp/stone ratio was also maximum recorded during both the years with the treatment T_6 FYM +75 % NPK+ *Azotobacter*+ PSB+ $ZnSO_4$(0.4). Similar findings tally in phalsa with the results of Yadav *et al*. (2008).

Physical characters of fruit *viz*., length, breadth and weight of fifty fruits (Table 3) were found significantly higher with the application of T_6 FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $ZnSO_4$(0.4%) in both the years, respectively for better development of physical quality in fruits may be attributed to use of appropriate biofertilizers, organic manures and micronutrients. Ram and Rajpoot (2000) reported a maximum increase in physical characters in fruits of guava was obtained with the application of *Azotobacter*. Similar results were also reported by Kumar and Shanmugavelu (1980 and 1988) in banana. Micronutrients like zinc is known as

Table 1 : Effect of integrated nutrient management on growth parameters of the phalsa

Sr. No.	Treatments	Shoot lenth(cm)		No. of shoot per plant		No. of leaves per plant		Intemodal length (cm)		Pruned wood weight after pruning (kg)	
		2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	FYM+100%NPK(control)	1.59	1.65	98.33	99.00	59.33	59.83	6.37	6.41	0.86	0.91
T_2	FYM+100%NPK+$ZnSO_4$(0.4%)	1.96	2.00	101.00	101.33	62.67	65.50	6.75	6.78	1.01	1.06
T_3	FYM+100%NPK+$FeSO_4$(0.4%)	2.00	2.07	102.33	103.00	65.47	65.83	6.83	6.86	1.12	1.18
T_4	FYM+75%NPK+*Azotobacter*	2.18	2.23	109.67	109.00	70.60	70.93	6.95	6.96	1.13	1.18
T_5	FYM+75%NPK+*Azotobacter*+PSB	2.24	2.28	104.33	105.33	71.00	71.17	7.05	7.07	1.14	1.23
T_6	FYM+75%NPK+*Azotobacter*+PSB+ nSO_4(0.4%)	2.65	2.68	117.33	118.67	100.73	101.17	7.43	7.46	1.70	1.83
T_7	FYM+75%NPK+*Azotobacter*+PSB+$FeSO_4$(0.4%)	2.58	2.61	115.33	116.67	96.97	97.17	7.28	7.31	1.50	1.56
T_8	FYM+50%NPK+*Azotobacter*	2.27	2.29	111.00	110.33	89.40	87.67	7.12	7.12	1.16	1.20
T_9	FYM+50%NPK+*Azotobacter*+PSB	2.38	2.38	103.33	104.67	91.87	87.33	7.17	7.18	1.20	1.25
T_{10}	FYM+50%NPK+*Azotobacter*+PSB+$ZnSO_4$(0.4%)	2.47	2.51	106.33	106.67	88.57	88.83	7.20	7.22	1.48	1.53
T_{11}	FYM+50%NPK+*Azotobacter*+PSB+$FeSO_4$(0.4%)	2.43	2.46	113.33	114.00	91.20	88.33	7.19	7.20	1.30	1.33
S.E.±		0.020	0.037	1.320	1.138	0.890	1.102	0.198	0.208	0.124	0.108
C.D.(P=0.05)		0.058	0.111	3.900	3.357	2.631	3.252	0.586	0.612	0.365	0.318

Table2 : Effect of integrated nutrient management on yield characters

Sr. No.	Treatments	No. of fruits per node		No. of fruiting node per shoot		Fruit yield kg/plant	
		2007-08	2008-09	2007-08	2009-09	2007-08	2008-09
T_1	FYM+100%NPK(control)	12.85	12.86	11.97	12.21	3.52	3.57
T_2	FYM+100%NPK+$ZnSO_4$(0.4%)	15.32	14.83	18.45	18.28	4.27	4.28
T_3	FYM+100%NPK+$FeSO_4$(0.4%)	13.87	13.98	17.08	17.12	3.74	3.83
T_4	FYM+75%NPK+*Azotobacter*	14.39	14.44	14.59	14.80	3.74	3.83
T_5	FYM+75%NPK+*Azotobacter*+PSB	14.71	14.85	14.01	14.09	3.85	3.95
T_6	FYM+75%NPK+*Azotobacter*+PSB+ $ZnSO_4$(0.4%)	15.93	16.23	25.12	24.76	5.06	5.23
T_7	FYM+75%NPK+*Azotobacter*+PSB+ $FeSO_4$(0.4%)	15.43	15.60	23.22	22.82	4.39	4.48
T_8	FYM+50%NPK+*Azotobacter*	14.75	14.78	17.37	17.38	3.69	3.72
T_9	FYM+50%NPK+*Azotobacter*+PSB	15.05	15.09	17.60	17.62	3.83	3.87
T_{10}	FYM+50%NPK+*Azotobacter*+PSB+ $ZnSO_4$(0.4%)	15.14	15.22	21.90	21.68	3.93	4.03
T_{11}	FYM+50%NPK+*Azotobacter*+PSB+ $FeSO_4$(0.4%)	15.05	15.23	19.98	19.92	3.80	3.90
S.E.±		0.295	0.301	0.121	0.176	0.039	0.058
C.D. (P=0.05)		0.871	0.887	0.359	0.520	0.115	0.171

Table3 : Effect of integrated nutrient management on physical character of phalsa fruit

Sr. No.	Treatments	Fruit size				Weight of fifty fruits(g)		Juice per cent		Pulp/stone ratio	
		Length(cm)		Breadth(cm)							
		2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	FYM+100%NPK(CONTROL)	0.94	0.96	1.11	1.12	30.17	30.57	42.10	42.27	1.19	1.20
T_2	FYM+100%NPK+$ZnSO_4$(0.4%)	1.01	1.03	1.12	1.14	33.87	34.17	44.87	45.00	1.27	1.28
T_3	FYM+100%NPK+$FeSO_4$(0.4%)	1.00	1.02	1.11	1.12	32.60	32.93	44.25	45.58	1.20	1.22
T_4	FYM+75%NPK+*Azotobacter*	0.95	0.99	1.18	1.20	33.23	33.53	44.60	44.78	1.24	1.25
T_5	FYM+75%NPK+*Azotobacter*+PSB	1.03	1.05	1.19	1.21	36.40	36.70	45.12	44.32	1.30	1.32
T_6	FYM+75%NPK+*Azotobacter*+PSB+ $ZnSO_4$(0.4%)	1.13	1.15	1.37	1.35	38.63	39.10	51.11	51.92	1.60	1.62
T_7	FYM+75%NPK+*Azotobacter*+PSB+ $FeSO_4$(0.4%)	1.11	1.13	1.19	1.22	37.03	37.53	50.47	50.87	1.51	1.53
T_8	FYM+50%NPK+*Azotobacter*	1.02	1.01	1.21	1.20	35.60	35.17	46.15	46.07	1.34	1.34
T_9	FYM+50%NPK+*Azotobacter*+PSB	1.00	1.02	1.22	1.21	34.57	34.47	46.19	46.20	1.41	1.43
T_{10}	FYM+50%NPK+*Azotobacter*+PSB+ $ZnSO_4$(0.4%)	1.02	1.04	1.15	1.17	37.73	37.87	47.10	47.20	1.45	1.46
T_{11}	FYM+50%NPK+*Azotobacter*+PSB+ $FeSO_4$(0.4%)	1.11	1.10	1.27	1.28	35.83	36.23	46.15	47.28	1.38	1.40
S.E.±		0.007	0.008	0.009	0.016	0.969	1.348	0.218	0.204	0.011	0.019
C.D. (P=0.05)		0.021	0.024	0.027	0.048	2.863	3.976	0.645	0.602	0.032	0.055

Table 4 : Effect of integrated nutrient management on chemical characters of the phalsa fruit

Sr. No.	Treatments	T.S.S.(%)		Reducing sugars (%)		Non-reducing sugars (%)		Total sugars (%)		Acidity(%)		Ascorbic acid (mg/100ml juice)	
		2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
T_1	FYM+100%NPK(control)	23.04	23.17	17.98	17.99	1.93	1.94	19.91	19.93	2.93	2.92	28.27	27.83
T_2	FYM+100%NPK+$ZnSO_4$(0.4%)	24.59	24.73	18.25	18.26	2.13	2.14	20.37	20.40	2.82	2.80	34.20	34.30
T_3	FYM+100%NPK+$FeSO_4$(0.4%)	23.95	24.00	18.08	18.09	2.01	2.03	20.09	20.12	2.81	2.79	33.73	33.87
T_4	FYM+75%NPK+*Azotobacter*	24.00	24.08	18.16	18.18	2.09	2.10	20.25	20.29	2.73	2.71	33.67	33.47
T_5	FYM+75%NPK+*Azotobacter*+PSB	25.12	25.23	18.23	18.24	2.13	2.14	20.34	20.42	2.71	2.49	34.43	34.20
T_6	FYM+75%NPK+*Azotobacter*+PSB+ $ZnSO_4$ (0.4%)	27.64	27.91	19.38	19.40	2.37	2.38	21.74	21.78	2.24	2.20	38.51	38.20
T_7	FYM+75%NPK+*Azotobacter*+PSB+ $FeSO_4$(0.4%)	27.04	27.06	19.23	19.25	2.33	2.35	21.57	21.59	2.43	2.41	37.70	37.33
T_8	FYM+50%NPK+*Azotobacter*	26.18	26.19	18.30	18.31	2.15	2.16	20.45	20.47	2.68	2.66	36.10	36.00
T_9	FYM+50%NPK+*Azotobacter*+PSB	26.16	26.18	18.25	18.26	2.11	2.11	20.35	20.37	2.67	2.63	36.43	36.20
T_{10}	FYM+50%NPK+*Azotobacter*+PSB+ $ZnSO_4$(0.4%)	26.88	26.93	18.77	18.79	2.20	2.21	20.97	21.00	2.50	2.48	37.00	36.80
T_{11}	FYM+50%NPK+*Azotobacter*+PSB+ $FeSO_4$ (0.4%)	26.82	26.86	18.64	18.65	2.20	2.22	20.84	20.88	2.56	2.54	36.87	36.73
S.E.±		0.030	0.070	0.013	0.013	0.011	0.012	0.016	0.020	0.023	0.070	0.169	0.302
C.D. (P=0.05)		0.088	0.206	0.037	0038	0.032	0.035	0.046	0.060	0.067	0.206	0.500	0.890

growth promoting element, playing a significant role in development of fruits. Same results were also observed by Kumar *et al*. (2004) in litchi and Singh *et al.* (2007) in aonla.

An observation recorded on chemical quality and composition of phalsa fruits, determining the quality due to effect of organic manure, biofertilizers and micronutrients showed a significant improvement in quality of fruits (Table 4). The TSS content were significantly influenced by application of FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $ZnSO_4$ (0.4%). Integrated nutrient management stimulated the function of number of enzymes in physiological process. The acids have either been converted into sugar and their derivatives by the reaction evolving reversal of glycolytic pathway or might be used into transpiration or both. The above findings are in agreement with the work of Suresh and Hasan (2001) in banana.

Integrated nutrient modules significantly increased total sugars, reducing and non reducing sugar contents during 2007-08 and 2008-09, respectively. This improvement with sugar contents of fruits is helpful in the process of photosynthesis, which ultimately lead to the accumulation of carbohydrates, which help in increasing the sugar contents of fruits. Increase in sugars by the foliar spray of zinc might be due to their stimulatory effect on increasing photosynthetic efficiency and metabolic activity in plant system, which might have helped the translocation and accumulation of chemical metabolites in mature fruits. Similar results were also reported by Verma *et al.* (2009) in aonla. Many results were also reported by many scientists in different crops Kumar and Shanmugvelu, (1980) in banana, Rathi and Bist, 2004 in pear.

It is evident from the both year of data (Table 4) that maximum reduction in acidity was found with the use of FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $ZnSO_4$ (0.4%) followed by T_7 FYM +75 per cent NPK+ *Azotobacter*+ PSB+ $FeSO_4$ (0.4%). The decreased acidity was noticed with the application of *Azotobacter* which is supported by the findings of Kumar and Shanmugvelu (1980) and maximum ascorbic acid content was found (38.51 and 38.20mg/100ml juice) during both the years, respectively by the application of treatment T_6. Urea stimulated the functioning of number of enzymes in the physiological process which probably increased the ascorbic acid content in fruits. Similar results were also reported by Dey *et al.* (2005). Ahlawat and Yamdagani (1981) reported that accumulation of TSS, ascorbic acid and total sugars in fruits of guava was found to be enhanced with increase dose of nutrients.

On the basis of above findings it may be concluded that use of organic nutrient and inorganic nutrient resources, micronutrient and biofertilizers enhance the soil fertility which ultimately increase the plant growth, fruit yield and quality of fruits. Which can also maintain and sustain the crop productivity and soil fertility.

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