

Effects of Different Doses of Fertilizers on Growth and Yield Components of Biodiesel Plant (*Jatropha curcas* L.)

(Kesan Dos Baja Berbeza ke atas Pertumbuhan dan Komponen Hasil Tumbuhan Biodiesel (*Jatropha curcas* L.))

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ABSTRACT

Effects of different doses of fertilizers on growth and yield components of biodiesel plant (*Jatropha curcas* L.), was made in the prevailing environment of University of Science and Technology Bannu. The experiment was carried out in randomized complete block design (RCBD) with three replications. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and potash in the shape of combined NPK, respectively, during sprouting of leaves and thereafter with each irrigation in split doses. The analysis of variance for number of branches per plant showed significant results indicated in ANOVA. Significantly the number of primary branches per plant 8.07 was recorded in T4 with the application of dose of (N P K: 2507.5 gm: 1091.5 gm: 501.5 gm). Maximum No. of secondary branches per plant (9.100) were recorded in T1 especially at both plots. Flower per inflorescence showed that maximum value (122.810) was recorded in T5 of especially at both plots. Inflorescence plant¹ showed that maximum value (39.477) were recorded in T1 and minimum value were noted as (12.733) at T3 on both the flats. The data for fruits per plant showed that maximum value (143.300) was recorded in T1. The seed index, which was the output of the aim of this research work, reflects highly significant differences in mean value observed for both subplots. Mean values showed that maximum seeds weight 45.86 was recorded in T1 of especially at both plots while low seed index was noted as 22.84 at T5 (N: 3400 gm, P: 1480 gm, K: 680 gm) at both the subplots.

Keywords: Bannu; biodiesel plant; NPK; UST

ABSTRAK

Kesan daripada dos baja yang berbeza ke atas komponen pertumbuhan dan hasil tumbuhan biodiesel (*Jatropha curcas* L.) dibuat dalam persekitaran semasa di Universiti Sains dan Teknologi Bannu. Penyelidikan telah dijalankan dalam reka bentuk blok lengkap (RCBD) dengan tiga replikasi. Nitrogen, fosforus dan kalium diaplikasikan dalam bentuk urea, super fosfat tunggal dan potas masing-masing dalam bentuk gabungan NPK, semasa daun bercambah dan selepas itu dalam setiap pengairan dengan dos berbeza. Analisis varians bagi bilangan dahan setiap tumbuhan menunjukkan hasil yang dinyatakan dalam ANOVA. Bilangan paling ketara untuk dahan setiap tumbuhan 8.07 direkodkan pada T4 dengan penggunaan dos (N P K: 2507.5 gm: 1091.5 gm: 501.5 gm). Bilangan maksimum dahan sekunder setiap tumbuhan (9.100) direkodkan pada T1 untuk kedua-dua petak. Bunga untuk setiap perbungaan menunjukkan nilai maksimum (122.810) direkodkan pada T5 untuk kedua-dua petak. Tumbuhan perbungaan menunjukkan nilai maksimum (39.477) telah direkodkan pada T1 dan nilai minimum dicatat sebagai (12.733) pada T3 ke atas kedua-dua dataran. Data untuk buah-buahan setiap tumbuhan menunjukkan nilai maksimum (143.300) direkodkan pada T1. Indeks benih yang merupakan output matlamat penyelidikan ini, menunjukkan perbezaan ketara untuk nilai min yang diperhatikan pada kedua-dua subpetak. Nilai min menunjukkan berat maksimum 45.86 direkodkan pada T1 untuk kedua-dua petak manakala indeks biji benih minimum telah direkod sebagai 22.84 pada T5 ((N: 3400 gm, P: 1480 gm, K: 680 gm) untuk kedua-dua subpetak.

Kata kunci: Bannu; NPK; tumbuhan biodiesel; UST

INTRODUCTION

Jatropha curcas L. belongs to Kingdom: Plantae, Class: Angiosperma, Order: Malpighiales, Family: Euphorbiaceae, Subfamily: Crotonoideae and Tribe: Jatrophae. The name *Jatropha* derived from Greek word 'iatro', meaning 'physician', and 'trophe', meaning 'nutrition, commonly named as physic nut'. It belongs to family Euphorbiaceae having 175 succulent plants, including trees and shrubs. Mature plants produce separate

male and female flowers. It is resistant to drought and pests. It contains highly toxic compounds. It produces seeds containing 27-40% oil, averaging 34.4%. After oil extraction the remaining press cake of seeds could also be considered for energy production. None of the *Jatropha* species have been properly domesticated. Rajagopal and Zilberman (2007) reported that the demand for plant-based feedstock for biodiesel production has received much attention in recent years due to green energy policy vis-

à-vis blending requirements of diesel adopted by many countries. However, as a result of despite their abundance use as oil and reclamation plants and their productivity is variable, and the long-term impact of their large-scale use on soil quality and the environment is unknown. Igbiosa et al. (2009) demonstrated potential broad spectrum antimicrobial activity of *J. curcas*. However, the current seed biomass output of *Jatropha* for production of biofuels is inadequate to completely replace fossil fuels (Ruth 2008). Despite growing advocacy for *Jatropha* for large-scale cultivation, its systematic yield improvement studies, especially the nutritional requirements of the crop in marginal lands of tropical agro climatic conditions have not been adequately addressed.

In recent years, *Jatropha curcas* L., has received considerable interest of the researchers as a potential source of non-edible vegetable oil. Its multifarious benefits as a source of green manure, soil ameliorator and improve rural economy by generating huge manpower employment during various stages of its cultivation and downstream processing makes it a potential candidate for large-scale plantation on marginal lands (Abdelgadir et al. 2007; Sunil et al. 2008; Rao et al. 2008; Kochhar et al. 2008; Kheira & Atta 2009; Mishra 2009; Behera et al. 2010). European Union and India have set targets of 10 and 20% replacement of transport fossil fuel with biodiesel by 2020 and 2012, respectively (Rosch & Skarka 2009; Biswas et al. 2010). *Jatropha curcas* L. has the possible potential of providing an alternate source of bio fuel which may be exploited because it has physico-chemical properties matching with diesel fuel. Khimani et al. (2003) concluded that use of 20 g urea, 120 g SSP and 16 g MOP to each pit at the time of planting of *Jatropha* and thereafter an application of 46:48:24 kg N:P:K ha⁻¹ was recorded as optimum.

Although plant growth and yield is considerably influenced by application of inorganic fertilizers, striking a balance between increased yields attributes and use of optimum level of Nitrogen. Phosphorus and Potassium is critical for *Jatropha* to advance as a marketable crop. As a result, the present study was undertaken to estimate the effect of different combinations of N, P and K fertilizers on development, growth, oil content and seed yield of *Jatropha* in prevailing environment of University of Science and Technology, Bannu.

MATERIALS AND METHODS

A field experiment was designed to evaluate the 'Effects of Different Doses of NPK based Fertilizers on Growth and Yield Components of (*Jatropha curcas* L.) on Site-Sandy Loam Soil during 2012' to study the response of *Jatropha curcas* L., to nitrogen, phosphorus and potassium level in the environment of Bannu. Details of the materials and methods used and the techniques which were adopted during the course of investigation are described below.

DESIGN AND LAYOUT

A field experiment of transplanted stumps with roots of Biodiesel plant, *Jatropha curcas* L., was laid out in a Randomized Complete Block Design with 15 treatments combinations keeping one absolute control and will be replicated three times. The data was recorded and analyzed. The brief sketch is highlighted as;

Replications	=	03
Treatment combinations	=	(04+01)
Row to row distance	=	(1.8 m)
Plant to plant distance	=	(1.8 m)
Total number of sub plots	=	5 per replication
Size of Sub plot	=	8.1 × 6.4 m

STATISTICAL ANALYSIS

The data regarding different plant parameters was averaged and subjected to statistical manipulation for the analysis of variance techniques to establish the level of variability among different block treatments of plants (Steel & Torri 1980).

FERTILIZER APPLICATIONS

Nitrogen, phosphorus and potassium were applied (in the form of urea, single super phosphate and potash in the shape of combined NPK, respectively, during sprouting of leaves and, thereafter with each irrigation in split doses.

T1	Control			
T2	NPK:	1912.5 gm:	1832.5 gm:	382.5 gm
T3	NPK:	2210.0 gm:	962.0 gm:	442 gm
T4	NPK:	2507.5 gm:	1091.5 gm:	501.5 gm
T5	NPK:	2805.0 gm:	1221.5 gm:	561 gm

PARAMETERS

Data was recorded on the parameters like number of primary branches plant⁻¹, number of secondary branches plant⁻¹, number of flowers plant⁻¹, number of inflorescence plant⁻¹, number of fruits plant⁻¹, number of seeds fruit⁻¹, 100 seeds weight and seed yield acre⁻¹.

RESULTS AND DISCUSSION

The results of the crop of *Jatropha* of Bio-Diesel Project is highlighted in tables and exposed with the help of graphic's figures. The analysis of variance for the traits concerned has been shown in Tables 1(a) to 5(a) while the mean values are shown in Tables 1 to 5 of the parameters recorded. Moreover, the mean data is well highlighted in graphic representations as shown in Figures 1 to 5. The average values of these ten plants under the following parameters were considered for further analysis and their achieved results are discussed as follows:

TABLE 1. Table of mean values of primary branches per plant

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	6.67	9.2	7.93
T2	8.17	7.1	7.63
T3	6.03	7.17	6.6
T4	8.53	7.6	8.07
T5	6.63	5.33	5.98
Mean	7.2	7.28	

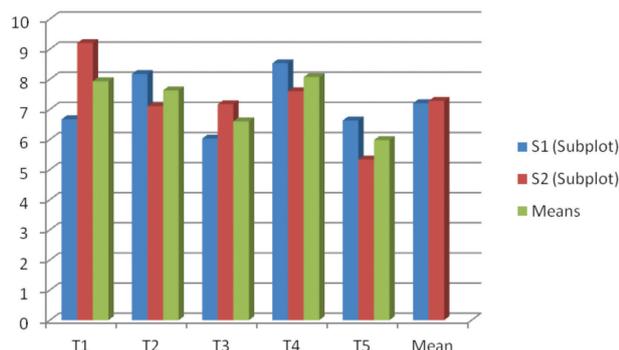


FIGURE 1. Graphic presentation of effects of NPK of primary branches per plant

NUMBER OF PRIMARY BRANCHES PLANT¹

Significantly the higher mean of number of branches per plant 8.07 was recorded in T4 with the application of dose of (NPK: 2507.5 gm: 1091.5 gm: 501.5 gm). Nevertheless minimum number of branches per plant with the mean value of 5.98 was recorded at T5 with the concentration of (NPK: 2805 gm: 1221 gm: 561 gm) in case of number of branches per plant as shown in Table 1. These observations are logically in full conformity with those reported by Venugopal (2006). Figure 1 clearly indicates the significant results.

NO. OF SECONDARY BRANCHES PLANT¹

The analysis of variance for number of secondary branches per plant reflects significant differences in mean value observed for both subplots. The results are fairly in agreement with those reported by Dinesh et al. (2001). The table of means (Table 2) showed that maximum number of secondary branches per plant (9.100) were recorded in T1 (Control) of especially at both plots. Despite the fact that minimum number of secondary branches per plant were noted as 5.533 at T5 (NPK: 3952 gm: 1924 gm: 884 gm) at both the flats. Figure 2 of graphic presentations clearly indicates the significant results.

FLOWER PER INFLORESCENCE

The analysis of variance for flower per inflorescence reflects significant differences in mean value observed

TABLE 2. Number of secondary branches per plant

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	7.000	9.100	8.050
T2	8.233	7.300	7.767
T3	5.900	6.657	6.233
T4	8.600	8.233	8.417
T5	7.200	5.533	6.367
Mean	7.387	7.347	

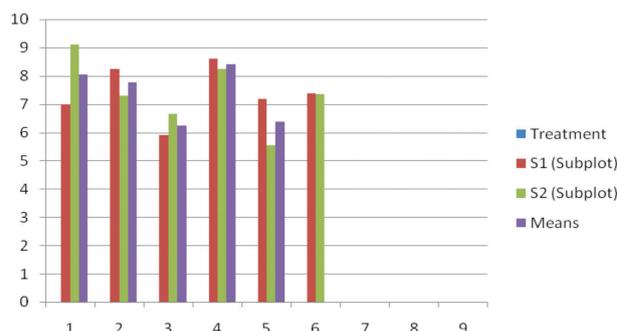


FIGURE 2. Graphic presentation of effects of NPK on No. of sec. branches plant¹

for both subplots. The results are fairly in agreement with those reported by Dinesh et al. (2001). The table of means (Table 3) showed that maximum flower per inflorescence (122.810) were recorded in T5 of especially at both plots. Despite the fact that minimum flower per inflorescence were noted as 64.810 at T4 at both the flats (Figure 3).

TABLE 3. Flower per inflorescence

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	100.740	108.800	104.770
T2	93.444	123.443	108.444
T3	77.333	93.163	85.248
T4	94.600	64.810	79.705
T5	122.810	80.887	101.848
Mean	97.785	94.221	

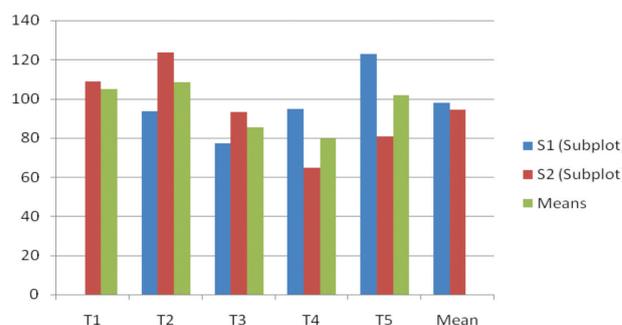


FIGURE 3. Graphic presentation of effects of NPK on flower per inflorescence

INFLORESCENCE PLANT¹

The analysis of variance for inflorescence plant¹ reflects significant differences in mean value observed for both subplots. The results are fairly in agreement with those reported by Dinesh et al. (2001). Table 4 shows that maximum inflorescence plant¹ (39.477) were recorded in T1 (Control) of especially at both plots. Despite the fact that minimum inflorescence plant¹ were noted as 12.733 at T3 on both the flats (Figure 4).

TABLE 4. Inflorescence per plant

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	26.033	39.477	32.755
T2	22.800	24.133	23.467
T3	12.733	25.100	18.917
T4	38.500	26.267	32.383
T5	22.267	12.967	17.617
Mean	24.467	25.589	

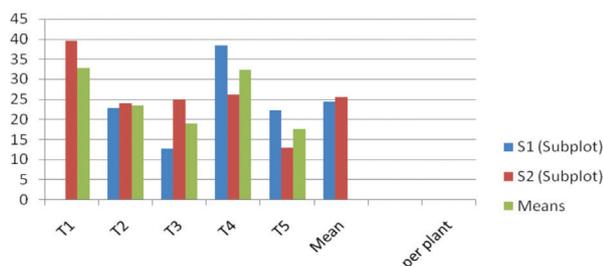


FIGURE 4. Graphic presentation of effects of NPK on inflorescence per plant

FRUITS PLANT¹

The analysis of variance for fruits per plant reflects significant differences in mean value observed for both subplots. The results are fairly in agreement with those reported by Dinesh et al. (2001). The table of means (Table 5) showed that maximum fruits per plant (143.300) were recorded in T1 (Control) of especially at both plots. Despite the fact that minimum fruits per plant were noted as (30.167) at T3 for both the flats. Graphic presentations clearly indicates the significant results.

SEED INDEX PLANT¹

The analysis of variance for seed index plant¹ reflects significant differences in mean value observed for both subplots. The results are fairly in agreement with those reported by Dinesh et al. (2001). The table of means (Table 6) showed that maximum seed index plant¹ (45.86) were recorded in T1 (Control) of especially at both plots. Despite the fact that minimum seed index plant¹ were noted as 22.84 at T5 (NPK: 3952 gm: 1924 gm: 884 gm) at both the flats. Figure 6 of graphic presentations clearly indicates the significant results.

TABLE 5. Fruit per plant

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	30.200	143.300	86.750
T2	101.633	70.667	86.150
T3	50.867	30.167	40.517
T4	97.333	87.367	92.350
T5	55.267	48.767	52.017
Mean	67.060	76.053	

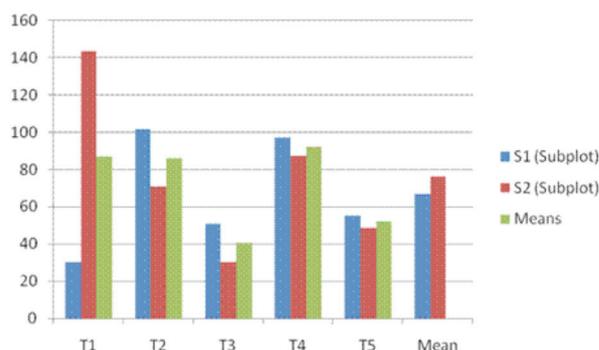


FIGURE 5. Graphic presentation of effects of NPK on fruit per plant

TABLE 6. Mean values of seed index per plant

Treatment	S1 (Subplot)	S2 (Subplot)	Means
T1	49.33	42.39	45.86
T2	44.34	41.35	42.84
T3	31.74	39.18	35.46
T4	29.26	31.17	30.21
T5	28.50	11.17	22.84
Mean	36.64	34.25	

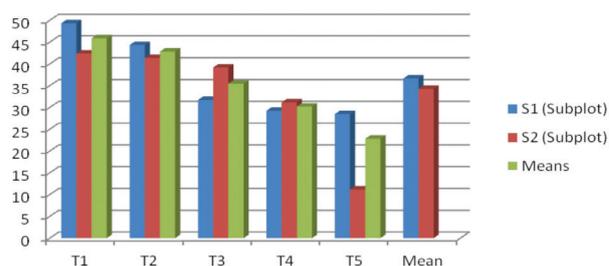


FIGURE 6. Graphic presentation of effects of NPK on seed index per plant

Anon (2003) found significance results on application of doses of 500 g SSP and 50 kg NPK (15:15:15) to *Jatropha*. Higher shelling percentage (47.8%) of *Jatropha* at 100:88 g urea: SSP plant¹ (54.5%) which was superior over 50:88 g urea: SSP plant¹ (51.9%) and 50:76 g urea: SSP plant¹ Anon (2005, 2004). Sasikala (2005) recorded 7500 kg ha⁻¹ dry seed yield with application of 20:120:20 kg urea, SSP and MOP ha⁻¹, respectively, to *Jatropha*. Joshi (2005) concluded

that N:P:K should be applied in the ratio of 46:48:24 kg ha⁻¹ to *Jatropha* in split doses from second year onwards so as to obtain higher yield. Venugopal (2006) in his studies conducted in Tamil Nadu on *Jatropha* indicated different doses of fertilizers for different soils. NPK at the rate of 60:40:20 kg ha⁻¹ was found optimum for black soils. Rana et al. (2006) studied the effect of varied levels of nitrogen on seed yield of castor and found significant increase in seed yield with an increase in the nitrogen level between 0, 60 and 120 kg N ha⁻¹. The highest was recorded in the treatment supplied with 120 kg N ha⁻¹ (31.5 q ha⁻¹). Patil and Parameshwarappa (2007) reported significantly higher seed yield of *Jatropha* at 80:80:80 kg N:P₂O₅:K₂O ha⁻¹ (1475 kg ha⁻¹) which was superior over 40:40:40 kg N:P₂O₅:K₂O ha⁻¹ (450 kg ha⁻¹) and 60:60:60 kg N:P₂O₅:K₂O ha⁻¹ (1000 kg ha⁻¹) they also reported significantly higher plant height at 80:80:80 kg N:P₂O₅:K₂O ha⁻¹ (2.53 cm) and higher collar diameter of at 80:80:80 kg N: P₂O₅:K₂O ha⁻¹ (36.08 cm) over 40:40:40 kg N: P₂O₅:K₂O ha⁻¹ (36.00 cm) and 60:60:60 kg N: P₂O₅:K₂O ha⁻¹ (34.33 cm). Yong et al. (2010) reported that the pooled analysis of the results indicated that the flowering phenomenon in *Jatropha* was earlier in N60 and N60 P80 treatments during the 1st and 2nd phase of flowering, respectively, as compared to other treatments. The results are in agreement with previous report in *Jatropha* where nitrogen at higher level hastened the flowering process.

CONCLUSION AND RECOMMENDATIONS

The seed index, which is the output of the aim of this research work, reflects highly significant differences in mean value observed for both subplots. Mean values showed that maximum seeds weight 45.86 were recorded in T1 (control) of especially at both plots. While low seed index was noted as 22.84 at T5 (N: 3400 gm, P: 1480 gm, K: 680 gm) at both the subplots. Flower per inflorescence showed that maximum value (122.810) was recorded in T5 of especially at both plots. Despite the fact that minimum flower per inflorescence were noted as (64.810) at T4 at both the flats. The table of means for fruits per plant showed that maximum value (143.300) were recorded in T1 (Control) of especially at both plots and minimum fruits per plant were noted as (30.167) at T3 both the flats. Inflorescence plant⁻¹ showed that maximum value (39.477) were recorded in T1 and minimum value were noted as (12.733) at T3 on both the flats. Significantly the number of primary branches per plant 8.07 was recorded in T4 with the application of dose of (NPK: 2507.5 gm: 1091.5 gm: 501.5 gm). The table of means showed that maximum number of secondary branches per plant (9.100) were recorded in T1 of especially at both plots. Despite the fact that minimum No. of secondary branches per plant were noted as (5.533) at T5 (NPK: 3952 gm: 1924 gm: 884 gm) at both the flats.

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