Research Article

EFFECT OF FERTILIZER DOSE AND SPLIT APPLICATION OF FERTILIZER ON GROWTH, YIELD AND NUTRIENT USE EFFICIENCY IN MULBERRY

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ABSTRACT

Field experiment was conducted at Central Sericultural Research and Training Institute, Berhampore- 742 101 during 2016 to study the effect of fertilizer dose and split application of fertilizer on growth, yield and nutrient use efficiency of mulberry leaves. The treatments comprised of four levels of fertilizer (75, 100, 125 & 150% RDF), two types of split application (2 splits: 15th & 45th day after pruning and 3 splits: 15th, 30th & 45th day after pruning). A control plot of 100% RDF with one time application of fertilizer on 15th day after pruning was also maintained. The experiment was laid out in randomized block design with three replications. Recommended dose of fertilizer was used at 67.2:36: 22.4 kg NPK ha^{-1} crop^{-1}. The required nutrient as per treatments were applied through Urea, DAP and MOP. The experimentation was done under existing S-1635 mulberry garden with 2'×2' spacing. The results revealed that mulberry showed positive response to fertilizer levels and split application of fertilizer. Growth and yield attributes were significantly higher under 125% RDF with 2 split application and this was on par with 150% RDF with in both 2 split and 3 split applications. Significantly higher leaf yield of 506.40 g/plant (14.07 t ha^{-1} crop^{-1}) was registered under fertilizer dose at 125% RDF with 2 splits. Total soluble protein (mg/g of fresh green weight) was 31.82% higher in 125% RDF with 2 splits than control. Nutrient use efficiency (NUE) was markedly decreased with higher fertilizer dose (*i.e.* 150% RDF) than lower fertilizer dose (75% RDF). The results indicated that 11.10% higher NUE was registered under 125% RDF with 2 splits compared to control. From the above study, it could be concluded that application of 84:45:25 kg NPK ha^{-1}crop^{-1} in 2 split was found to be a suitable technology for achieving higher mulberry leaf yield with enhanced fertilizer use efficiency. However, split application of fertilizer could reduce total nitrate emissions from mulberry field due to better nutrient use efficiency and this could one of the climate change mitigation option.

INTRODUCTION

Mulberry is a deep-rooted perennial plant, which is cultivated for its leaves. The quality of mulberry silk is directly dependent on the nutrition of leaf which influences healthy growth of silkworm larvae and thereby the good cocoon crop (Bongale *et al.*, 2000). It is estimated that one tonne of mulberry leaves will produce approximately 25-30 kg cocoons when fed to silkworms (Rangaswami *et al.*, 1976). One hectare of fertile land yields about 15-40 tonnes of mulberry leaves per annum depending on the variety of mulberry, agronomic practices and climatic conditions. However, the leaf yield and quality of mulberry leaves highly depending upon the various agronomic management *viz.*, rate of fertilizer application, soil type, plant variety, season, cropping density and water use among which inappropriate fertilizer management is major one. The nutrient management in mulberry is very much essential to sustain the leaf productivity and quality as mulberry growing soils are losing their fertility level due to high depletion of nutrients from the soil throughout the year. Wang *et al.* (2001) have reported that yield and quality are significantly increased by adequate fertilization.

Fertilizers application is more common in intensive mulberry cultivation which requires a high amount of NPK nutrients due to production of a great deal of biomass. Under irrigated conditions in Eastern and North Eastern areas, fertilizers (NPK) are applied @ 67.2:36:22.4 kg NPK ha^{-1} crop^{-1} in single dose on 3rd week of each pruning for mulberry which was recommended since 30 years back. However, continues cultivation of mulberry in the same field year after year depletes the soil of its fertility and also use up soil nutrients are being far greater than in any other cultivated crop like rice, wheat or maize due to higher biomass production. Hence, it is essential to supply adequate NPK nutrients through fertilizer application, in order to maintain the fertility level and higher leaf productivity and quality.

Further, time as well as dosage of fertilizer application plays an important role in the growth and development of mulberry as well as nutrient balance in the soil. Inappropriate application and injudicious use of NPK can results in lesser leaf productivity and nutrient use efficiency. It is therefore important that essential NPK nutrients are required to be supplied to crops in desirable quantities and at the right time during the growth period. To optimize the best time of fertilizer application for enhanced utilization of applied nutrients and also for getting higher leaf yield, it is necessary to split the optimum dose. Hence, the current study was carried out to determine effect of fertilizer dose and its split application on growth, yield and nutrient use efficiency in mulberry.

MATERIALS AND METHODS

The experiment was carried out during 2016 at Central Sericultural Research and Training Institute, Berhampore, which lies in gangetic alluvial agro climatic zone of the West Bengal. The experimental site is geographically situated at 24°05' North latitude and 88°15' East longitude at an altitude of 18 meters (59 ft) above mean sea level. The experimental site soil was clay loam with pH of 7.5. The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice. Treatments consisted of two factors *viz.,* four fertilizer levels and two types split application, T_1: 75% RDF with 3 split application (15, 30 & 45 days after pruning (DAP), T_2: 75% RDF with 2 split application (15 & 45 DAP), T_3: 100% RDF with 3 split application (15, 30 & 45 DAP), T_4: 100% RDF with 2 split application (15 & 45 DAP), T_5: 125% RDF with 3 split application (15, 30 & 45 DAP), T_6: 125% RDF with 2 split application (15 & 45 DAP), T_7: 150% RDF with 3 split application (15, 30 & 45 DAP), T_8: 150% RDF with 2 split application (15 & 45 DAP) and T_9: 100% RDF with one time application (15 DAP) (Farmers practice) as control. The recommended dose of fertilizer @ 67.2:36: 22.4 kg NPK ha^{-1} crop^{-1} was used for the experimentation. The twelve years old S-1635 mulberry garden with 2'×2' spacing was selected for experimentation. Initially the mulberry garden was prunned at a height 20 cm above the soil surface (bottom pruning) followed by one digging was done. Two hand weeding were carried out at 13th and 43rd day after pruning. However, all plots were kept weed free throughout the experimental period by manual uprooting of weeds. Irrigation was not done during experimentation period due to very frequent rainfall. Urea, Di-Ammonium Phosphate and Muriate of Potash was used as source of fertilizers. For treatments T_1, T_3, T_5, T_7, total quantity of fertilizers was equally divided into three parts and applied on 15th, 30th and 45th day after pruning. Whereas, total quantity of fertilizers was equally divided into two parts and applied on 15th and 45th day after pruning for the treatments of T_2, T_4, T_6 and T_8. The required quantity fertilizers for different treatments were weighed separately and applied close to the plant on either side along the row. For farmers practice (T_{11}), the entire dose of fertilizer was applied in single dose at 15th day after pruning. After application, the fertiliser was incorporated well into the soil by digging with spade in all the treatments.

For analyzing growth and development of the crop, ten plants were selected at random from each net plot area in each treatment and were tagged to record various growth and yield parameters at 60 DAP. The average values were used for analysis. Leaf yield per plant was recorded from net plot area at 60 DAP. Protein content of leaves was estimated by Lowry's method (Lowry *et al*., 1951) at 60 DAP. The amount of protein (mg) per gram of the fresh weight is expressed. Leaf chlorophyll index were measured on the fifth fully expanded leaf from the top of the each plant by using an SPAD meter AT 60 DAP. The data were taken around the midpoint near the midrib of each leaf sample (Peng *et al.,* 1992) and averaged. Moisture percentage was calculated as follows,

$$\text{Leaf Moisture percentage} = \frac{\text{Fresh leaf weight - Oven dry weight}}{\text{Fresh leaf weight}} \times 100$$

The formula given below was used to find out the nutrient use efficiency of different treatments and expressed in kg of leaves kg-1 NPK applied (Yadav, 2003).

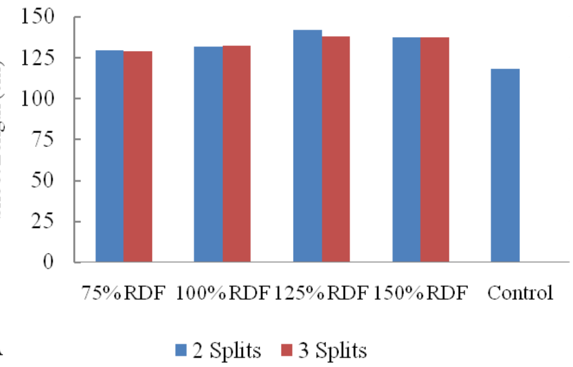
$$\text{NUE (kg of leaf kg}^{-1}\text{ NPK applied)} = \frac{\text{Leaf yield (kg ha}^{-1}\text{ crop}^{-1}\text{)}}{\text{Nutrients (NPK) applied (kg ha}^{-1}\text{ crop}^{-1}\text{)}}$$

The cost of the inputs at prevailing market rates were taken into account to work out the cost of cultivation per hectare per crop. Data were statistically analyzed by standard procedure of Gomez and Gomez (2010).

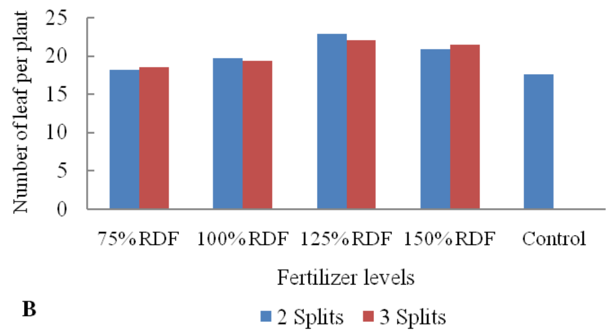
RESULTS AND DISCUSSION

Effect on plant growth, yield and quality

Two split application of 125% RDF (84 kg N, 45 kg P and 28 kg K/ha/crop) on 15th and 45th day after pruning (T_6) recorded significantly higher shoot length (142.2 cm) and number of leaf per plant (22.9) in mulberry over one time application of 100% RDF (67.2 kg N, 36 kg P and 22.4 kg K/ha/crop) (T_9) and application of 75% RDF (50.4 kg N, 27 kg P and 16.8 kg K/ha/crop) in two (T_2) and three (T_1) split (Fig. B & C). However, application of 125% RDF in three split (T_5) and 150% RDF (100.8 kg N, 54 kg P and 33.6 kg K/ha/crop) with two (T_8) and three (T_7) split resulted on par shoot length and number of leaf per plant with 125% RDF with two split. Similarly, significantly higher number of shoot per plant (12.6) was recorded in application of 125% RDF in two split (T_6) than rest of the treatments (Fig. A). Increment in shoot length, number of leaves per plant and number of shoots per plant with application of 125% RDF in two splits (T_6) over one time application of 100% RDF (T_9) was 20.16, 30.1 and 41.4%, respectively. This resultS in agreement with Paul and Qaiyyum (2009) who reported that increased fertilizer dose of 300 kg N, 150 kg P, and 100 kg K/ha/yr along with two irrigations in a month was found to be the best for higher leaf yield, leaf moisture and leaf nutrient contents of mulberry plants (var. BM-3). Rajegowda *et al.* (1999) have also reported that higher plant growth parameters due to increased application of fertilize dose of 400:180 N&K kg/ha/year in M-5 mulberry variety as compared to 300:120 N&K kg/ha/year.



A



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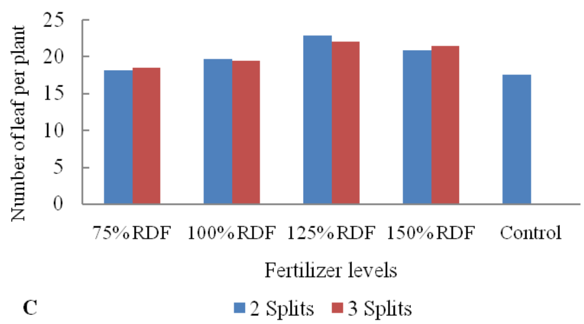

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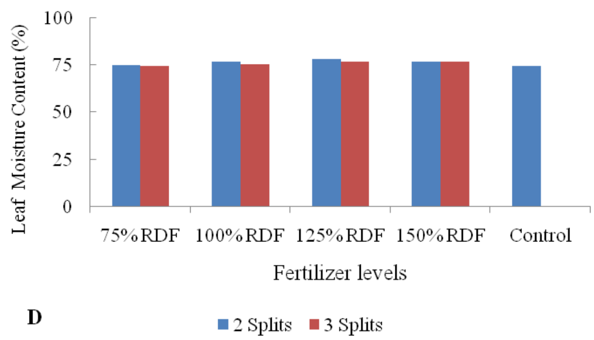
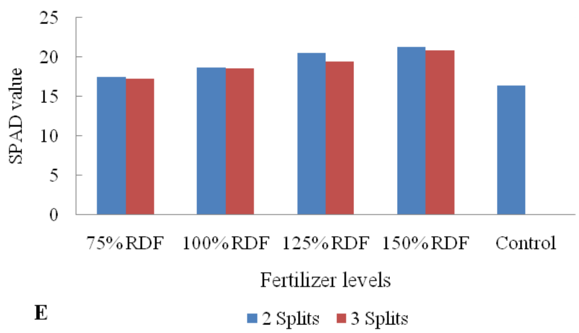


D

Similarly, leaf pigment content (SPAD values) showed significant differences among the treatments, 125 and 150% RDF in two (20.5) and three (21.3) splits application increased significantly higher leaf pigment content (SPAD values) than rest of the treatments (Fig. E). Whereas, the minimum leaf pigment content (SPAD values) (16.4) was registered in one time application of 100% RDF (Control). The increase in SPAD values in the leaves was probably generated by the level of NPK fertilization. According to Ciecko *et al.* (2004), the greater amount of NPK fertilizers is accompanied by the higher total chlorophyll content in plant material. According to Nalborczyk *et al.* (1994), nitrogen fertilization affects chlorophyll content in plants. Janardhan *et al.* (2005) reported that more amount of nitrogen (614 kg/ha) contributed by recommended dose of farmyard manure and fertilizers compared to other treatments (0 to 250 kg/ha) leading to more chlorophyll content and higher mulberry leaf yield.

Application of higher NPK fertilizers significantly increased all the characters over the control. Among the treatments, no significant differences were observed in leaf and shoot yields between the fertilizing split into two and three applications in both 125 and 150% RDF (Fig. G & I). However, they attained significantly greater leaf and shoot yield than the other treatments. The highest leaf yield (506.4 g per plant) was recorded with application of 125% RDF (84 kg N, 45 kg P and 28 kg K/ha/crop) in two splits (T_6) which was significantly superior than T_9, T_1 and T_2. The lowest leaf yield of 364.6 g/plant was registered with one time application of 100% RDF (T_9) in the present investigation. Compared to the control (T_9), leaf yield/plant of T_6, T_7, and T_8 was increased by 38.89, 31.29 and 32.06%, respectively. Such result was reported by Miah (1989) that by the application of N, P, and K fertilizers at the rate of 400 kg N, 200 kg P, and 150 kg K/ha/yr, leaf yield was increased by 77.92% over the control. Ray (1978) have also reported that applied N fertilizer at the rate of 150, 300, 600, and 900 kg/ha/yr and observed that leaf yield increased by 88% in the highest dose. Likewise, two times splitting of 125% RDF at 15th and 45th day (T_6) resulted significantly higher shoot weight (420.50 g/plant) than T_9 (301.5 g/plant) and T_1 (319.5 g/plant). Further, splitting of recommended fertilizers increased leaf yield significantly than single time application in the present study. Leaf yield increment was 23.58 and 18.62% in two and three split application, respectively than single time application at 100% RDF. Increased leaf yield under T_6 might be due to maintaining the required NPK nutrient concentration in the root zone by splitting of enhanced fertilizer dose. The split application of NPK nutrients improved the availability of nutrients in the root zone during critical stages of the crop. The split application also increased the quantum of available nitrogen, phosphorus and potassium in the soil which ultimately favored the increased NPK uptake by crop. Similar result, were also reported by Zaidi *et al.* (2007) in Rice, Shah *et al.* (2006) in Mungbeen.



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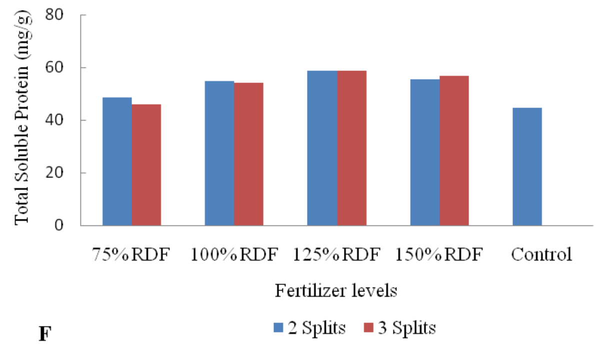

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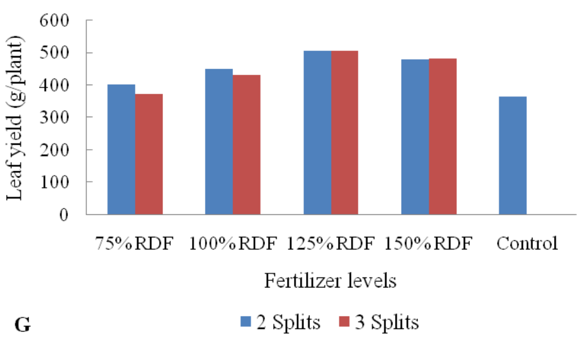

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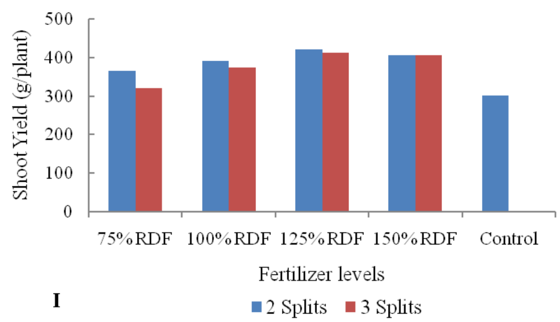
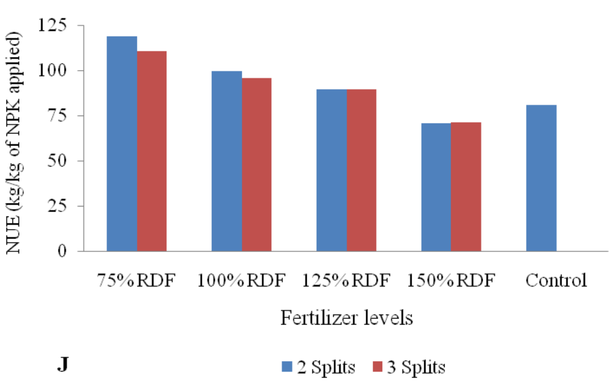


I



J

With regards to leaf quality, present investigation revealed that application of 125% RDF in two split treatment resulted 31.82% higher total soluble protein (mg/g of fresh leaf weight) than control (Fig. F). No significant variation was found between T_3, T_4, T_5, T_6, T_7, T_8 treatments with respect to total soluble protein. Whereas, there were no significant difference in moisture content among the treatments but the control treatment showed lower leaf moisture content than the other treatments. The highest moisture content of fresh leaves was obtained with the application of 125% RDF in two split (85.50%) followed by 125% RDF in three split (Fig. D). Paul and Qaiyyum (2009) have reported that nutritional components of mulberry leaf, such as leaf moisture, crude protein, reducing sugar, total sugar, starch and soluble carbohydrate increased significantly with the increased doses of NPK fertilizers. Several workers have reported similar results. Miah (1989) observed that with the progressive increase of NPK fertilizers, leaf constituents like moisture, crude protein, total sugar, reducing sugar, starch and soluble carbohydrate contents increased gradually. It was also reported by Quader *et al.* (1972) that crude protein, sugar, and leaf moisture increased by the application of increased dose of fertilizer.

Effect on nutrient use efficiency

Different fertilizer levels and its split application have shown significant variation in nutrient use efficiency (NUE) of mulberry (Fig. J). In the present study, low (75% RDF), medium (100 and 125% RDF) with split application in both two time and three time have resulted higher nutrient use efficiency than control; however, the high dose (150% RDF) recorded decreased NUE. This suggests that applying fertilizer in higher amounts might have resulted in more nutrient losses. Sharif *et al.* (1993) and Zada *et al.* (2000) reported that nutrient use efficiency increased with increasing fertilizer rates up to a certain level and then started to decline. It was found that 67.18% higher NUE was registered under 75% RDF with 2 splits (T_2) compared to 150% RDF with 2 splits (T_8) in the present study. The trend of increasing NUE is inversely proportional to the fertigation levels in the present study. This result in conformity with Pikul *et al.* (2005), who commented that as applied N decreases, NUE continues to increase. Abdul Rehman *et al.* (2011) also reported that fertilizer use efficiency and Nitrogen use efficiency were significantly lower with the high fertilizer dose (300-150-150 kg NPK ha^{-1}) than with the low or medium doses. The present recommended fertilizer rate of 100% RDF with one time application resulted nutrient use efficiency of 80.6 kg/ kg of NPK applied whereas, 125% RDF with two split application registered nutrient use efficiency of 89.6 kg per kg NPK applied. When compared to control, 125% RDF with two split application registered 11.1% higher NUE.

CONCLUSION

Among the fertilizer dose and its split application compared in this experiment, 125% RDF with two split application was found to adapt and perform better than the remaining 75, 100 and 150% RDF. Application of 125% RDF in two split considerably enhances nutrient use efficiency than control. Therefore, considering the growth attributes, leaf yield and quality variables studied, medium dose of 125% RDF (84 kg N, 45 kg P and 28 kg K/ha/crop) with two split applications on 15th and 45th day after pruning appeared to be the optimum dose of NPK fertilizers for S-1635 mulberry variety.

REFERENCES

Abdul Rehman, M., S. Farrukh, E.S. Muhammad, H. Safdar and A. Naeem. 2011. Grain quality, nutrient use efficiency, and bioeconomics of maize under different sowing methods and NPK levels. *Chilean Journal of Agricultural Research,* 71(4).

Abusahel, A. and K.G. Shanmugavelu. 1988. Studies on the effect of organic versus inorganic sources of nitrogen on growth, yield and quality of okra. Indian Journal of Horticulture, 45 (2): 312-318.

Ahmed, M. 1986. Effect of nitrogen fertilizer (urea) on *Morus alba* leaf yield. *Pak. J.* OF Forestry, 36,19-22.

Bongale, U. D., S. N. Gowda and V. M. Narayana, 2000. Effect of different plant densities and nitrogen levels on Viswa (DD), S-36 and M-5 mulberry *(Morus indica L.*) varieties under irrigated condition. *Indian Journal of Sericulture,* 39.

Gomez, K.A. and Gomez. 2010. Statistical Procedures for Agricultural Research. 2nd Edn. John Wiley and Sons, New York.

Islam, R., M.A. Bari and Z. Ahsan. 1982. Effect of different levels of fertilizers on leaf yield of mulberry under the irrigated condition. *Bangladesh J. Agric.* 6-7: 25- 30.

Islam, R., M. A. Bari and R. Ali. 1985. Effect of nitrogen, phosphorus and potassium and their combination on the leaf yield of mulberry. *J. Asiatic Soc. Bangladesh* (Sc.), 11, 1-5.

Lowry, O. H., N. J. Rosebrogh, A. L. Farr and R. J. Randall. 1951. Protein measurement with the Folin phenol reagent. *Biol. Chem,* 193-265.

Miah, M. A. B. 1989. Studies on the growth and yield of mulberry *(Morus alba L.).* Ph.D. Thesis. University of Rajshahi, Bangladesh.

Nalborczyk, E., E. Wróblewska, E. Marcinkowska and R. Roszewski. 1994. Amaranthus – prospect cultivation and utilization. Wyd. SGGW, Warszawa.

Paul, N. K. and M. A. Qaiyyum. 2009. Effect of different levels of npk fertilizers and irrigation on yield and nutritive quality of mulberry leaf. *Bangladesh J. Agril. Res.* **34**(3): 435-442.

Peng, S., F. V. Garcia, R. C. Laza and K. G. Cassman. 1992. Leaf thickness affects the estimation of leaf N using a chlorophyll meter. IRRI Newsletter, **17**(6), 19-20.

Pikul, J. L., L. Hammack and W. E. Riedell. 2005. Corn yield, nitrogen use and corn rootworm infestation of rotations in the northern Corn Belt. Agronomy Journal, 97, 854-863.

Quader, M. A., M. A. Qayyum, A. A. Sarkar, M. A. Rab, and S. U. Ahmed. 1992. Varietal response to NPK-fertilizers in combination with foliar spray of urea on leaf yield and quality of mulberry. *Bull. Sericult. Res.* 3, 54-66.

Rajegowda, S. M. A., M. K. Jayaramaiah and W. Maibaum. 1999. Response of mulberry (Morus indica L.) to nitrogen and potassium sulphate levels and its economics. XVIII International Sericultural Commission Congress, 12-16 October, Bangkok.

Rangaswamy, G., S. M. N. Narasimhanna, S. K. Kasiviswanathan, S. C. R. Sastry and S. J. Manjeet. 1976. Mulberry cultivation, FAO, Agriculture, *Sericulture Bulletin*.

Ray, D. 1978. Effect of different doses of ammonium sulphate and lime on soil composition, leaf yield and nutritive value of mulberry leaf. Annual Report. Central Sericulture Research and Training Institute, Berhamapur, India. 51-55.

Shah, S.K., A. Hussain, M. Khan, P. Memon, M.M. Yousuf, M. Imita, Saleem, U.H., Nizamuddin. 2006. Effect of different method and rates of phosphorous application in mungbeen. Soil & Environ., **25** (1): 55-58.

Sharif, M., S. Hussain, S. A. Rizvi and J. K. Khattak. 1993. Maize response to potassium fertilizer at Mardan. *Sarhad Journal of Agriculture,* **9**: 257-261.

Subbarayappa, C. T., A. K. Sinha, P. Sandareswaran, N. R. Singhvi and R. K. Datta. 1994. Effect of split doses of fertilizers on yield of mulberry leaves. *Indian J. Seric.* 33: 72-73.

Tiwari, N. K., S. F. A. Zaidi, C. K. Singh and R. K. Singh. 2016. Effect of split application of NPK fertility on nutrient uptake by hybrid rice *(Oryza sativa L.)* and soil health. Agriculture Update, 11 (1), 75-78.

Wang, B., X. Dai and R. Ding. 2001. Sericulture of Jiangsu 3 (1), 13-15. World Bank (2008b), "World development report: Agriculture for development", The world bank group.

Yadav, R.L. 2003. Assessing on-farm efficiency and economics of fertilizer N, P and K in rice wheat systems of India. *Field Crops Research*, 18: 39-51.

Zada, K., P. Shah and M. Arif. 2000. Management of organic farming: effectiveness of farm yard manure (FYM) and nitrogen for maize productivity. Sarhad Journal of Agriculture, 16,461-465.

Zaidi, S.F.A., H. P. Tripathi and B. Singh. 2007. Effect of N application timing on nitrogen use efficiency of rice. Oryza, 44 (3): 243-243.

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