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Original Research Article

IMPACT OF MACRONUTRIENTS ON THE PRODUCTION OF CLEAN AND HEALTHY MANGO NURSERY PLANTS IN POLYBAGS UNDER NURSERY TUNNEL

IQBAL A[1], MUSTAFA G[1], IMRAN M[1], HAMEED A[1], HUSSAIN R[2], AHMAD NH[4], KIRAN S[2,3], IQBAL J[2]*, AIN NU[5], SHAH SAH[6]

[1]*Mango Research Institute, Old Shujabad Road, Multan, Pakistan*
[2]*Mango Research Station, Basti Malook Road, Tehsil Shujabad, District Multan, Pakistan*
[3]*State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing, 210008 China*
[4]*Cotton Research Station, Old Shujabad Road, Multan, Pakistan*
[5]*Provincial Reference Fertilizer Testing Laboratory Raiwind Lahore, Pakistan*
[6]*Soil and Water Testing Laboratory, Mianwali, Pakistan*
**Correspondence author email address:* javedsaqi@yahoo.com

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Abstract: *Mango nursery production under polybags highly dependable on application of various fertilizers for the development of healthy and vigorous nursery plants. Mango nursery was grown in polybags placed under nursery tunnel. The fertilizer (N:P:K 20:20:20) was applied as control or no application, 5g, 10g, 15g and 20g into the polybags after 30 days of seedling transplanting into poly pots followed by irrigation of 500ml water into the pots. The data was recorded after 30, 60 and 90 days interval in terms of plant height, root length, number of leaves per plant, number of vegetative flushes per plants after application of nutrition to the plants. The results revealed that the maximum plant height 67.21cm was observed when pots were fertilized @ 10g per pots followed by irrigation of 500ml water while root length 22cm, number of leaves per plants 31.33 and number of vegetative flushes 8 per plants were observed when mango nursey pots were fertilized with 10g per pot.*

Keywords: mango nursery, plant height, root length, number of leaves, number of flushes

Introduction

Pakistan is blessed with the favourable agro-climatic conditions required to flourish mango cultivation. The phenological events in mango under sub-tropical conditions of Punjab is postharvest vegetative growth, root growth, dormancy, flower initiation and fruit development which entails for a ample supply of nutrients for regulation of mango crop (Jilani *et al.*, 2010). Applying the wise use of nutrients at the right time is necessary to overcome nutrient disorders, produce healthy growth and premium quality as well as quantity of fruits. Mango production in Brazil is (12.6 tonnes ha^{-1}) while in Pakistan it has (11.2 tonnes ha^{-1}) average mango yield than the majority of the world's top mango fruit producing nations (Kiran *et al.*, 2021). Although, if appropriate management is used, there is still a significant potential to boost per-hectare yield because Pakistan soil and climate are excellent for producing maximum yields with good quality fruits (Naik and Bhatt, 2017). One of the key element of mango producing technology is nutrient management. If the right nutrients are applied at the right growing stage using the right techniques, mango quality and yield could be increased (Iqbal *et al.*, 2021a).

Mango production in Pakistan is 1.68 million tonnes, it is lesser as estimated due to lack of understanding by growers and unable to use modern production technologies, whereas China has (11.4 tonnes $hectare^{-1}$) and Brazil (12.6 tonnes $hectare^{-1}$) are some of the other significant mango-producing nations in the globe (Bibi *et al.*, 2019). Therefore, a high yield and high-quality mango crop may be produced with the right understanding of the mango development pattern. In reality, using the appropriate fertilizers in the right amount and at the appropriate time is crucial for getting better results (Murtaza *et al.*, 2020). Previously, limited work has been done regarding the fertilizer management on mango production in the world as well as in Pakistan (Jilani *et al.*, 2010). According to studies, mango trees fertilized with farmyard manure, synthetic fertiliser (NPK) and with pruning application produced 395, 293 or 310 number of fruits per tree than control (Rani *et al.*, 2020). In a study, NPK was sprayed to young trees in various combinations and rates. A significant vegetative growth and yield were found to be achieved with the lowest N rate (100 g N/tree) (Kacha *et al.*, 2021). Phosphorous was unlikely to have strong impact on

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energy reserves in plants, whereas K had positive outcomes for the activation of 35 various enzymatic activation in plants in terms of mango yield. Pruning at a height of 4 m yielded the maximum shoot length, shoot girth, number of leaves per shoot, and tree spread when 800 g N, 300 g P_2O_5, 1000 g K_2O, and 50 kg of FYM were applied (Bains and Pant, 2003). When NPK is combined with Azospirillum and VAM fungal inoculation, maximum blooming (63.60%) and fruiting (71.33%) are observed (Azam *et al.*, 2020). Salama *et al.*, (2016) discovered that using KNO_3 in conjunction with urea (5 L KNO_3 (4%) + 0.5 g urea/tree and 5 L KNO_3 (4%) + 1 g urea/tree) increased reproductivity and yield. Wang *et al.*, (2022) discovered that 100% compost fertiliser greatly improved the fruiting features and physiochemical parameters of the mango fruit cv. Fajri Kalan. Meanwhile, the organic compost fertiliser administered at 100% level had the least effect (Kacha *et al.*, 2021).

In order to boost mango plant health and vegetative growth, it is important to concentrate on the soil nutrient availability and its assimilation in plants (Correia *et al.*, 2018). The nitrogen, phosphorus, potassium and sulphur in soil as well as their uptake mechanism by plant are vital for healthy canopy build up (Kiran *et al.*, 2022). Green and clean vegetative flushes ensures good yield by correcting fertiliser application in split doses, conversely yearly treatments may not be adequate, particularly on soils with high pH and calcareous characters (Zaghum *et al.*, 2022), as these soils render nutrients inaccessible owing to nutrient fixation, volatilization and leaching losses (Iqbal *et al.*, 2021b). As a result, applying nutrients at the correct time and in the right amount (Munir *et al.*, 2022), while keeping crucial phenological stages in mind may be a valuable method for achieving good output on such soils (Ghaffar *et al.*, 2022). Dubey *et al.*, (2021) found a substantial link between leaf nitrogen content and yield, but no influence on leaf potassium contents. Similarly, Wahdan *et al.*, (2011) achieved the highest yield when the leaf nitrogen content was attained 1.35%. Kumar *et al.*, (2013) investigated the relationship between leaf nutrient levels and yield in 14th year-old mango trees of cv. Banganapalle. Reddy *et al.*, (2001) discovered that the optimal leaf nutrient level was found nitrogen as 1.00-1.5%, phosphorous 0.07-0.10% and potassium 0.60-0.75% in a series of experiments. These findings augmented to use leaf nutrient diagnostic symptom and nutrient analysis as a nutritional indexing parameter for a healthy a vigorous mango plant. In the past, researchers focused on using the appropriate amount of fertiliser to boost mango yields, but very little study has been done on the split administration of fertilisers on regular basis. The goal of this study was to examine the influence of primary macronutrients N, P, and K delivery to plants in substratum utilized in polybags under poly tunnel conditions throughout the year in split doses on building a healthy, clean and vigorous mango nursery plants.

Materials and methods

The experiment was conducted at Certified Mango Nursery of Mango Research Institute, Multan, during two consecutive years 2020 and 2021. The site's GPS location was 30.09012°N and 71.26043°E having 126m elevation from sea level and 186.6 mm annual precipitation. The permanent iron nursey structure hut shaped tunnel was installed having length 100feet, width 30feet and height 10feet, which accommodates approximately 5000 polybags. The nursery structure covered with plant net having 60% shade to protect the young saplings from heat while transparent polyethylene sheet was used to cover during winter season (November to March) to protect plants from ill effects of cold weather.

Stone sowing

Fresh mango stones were extracted and sown in specialized nursery trays having dimension of 1m x 1m and 9cm height, the bottom surface was porous for easy water drainage. The freshly extracted mango stones were placed in seedling trays and covered with sugarcane bagasse and gently irrigated on alternate days, to keep the germination medium moist. After 15 days the stones were started emergence.

Size of polythene bags

The polyethylene bags used for this experiment were made from fresh plastic materials and avoid reused materials for bag making, as they have not tensile strength to be used in nursery for extended period. The polyethylene bags had dimension of 14inches length and 10inches wide. The poly bags have small holes of dimension 10mm at one third lower part and have total 24 holes for easy passage for excess water drainage. Poly bags has black in colour and 10mm sheet thickness.

Media preparation

The poly bags filled with supporting media/substratum which contain sugarcane baggasse, river silt, coconut coir with ratio of 65.30.05 v/v basis. The whole media ingredients were thoroughly mixed and filled the polybags which approximately accommodates 1.5 kg substratum.

Shifting of seedling plants into poly bags

The germinated mango seedling which attained the first leaves into dark green colour and in full turgid position, then seedling along with stones gently pulled out with the help of finger and the tap root trimmed at 5cm length as root training approach in order to make fibrous roots rather to elongate this tap root alone into the medium.

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NPK fertilizer

The fertilizer was purchased from well reputed source which contain N, P, K ingredients as (20.20.20) percent. This fertilizer was weighed and applied into the poly bags just after one month of seedling shifting into polybags. After application of weighed fertilizer according to the treatment plan, apply 500ml water to each pot for irrigation purpose.

Experimental design and observation of variables

The experiment was completely randomized design (CRD) with four fertilizer doses, three intervals and two years and three replications. The doses of NPK fertilizer were 5 g, 10 g, 15 g and control. The parameters i.e. plant height, root length, number of leaf and number of flushes were observed after 60, 90 and 120 days after transplanting in to poly bags intervals. Plant height was measured from the base to the tip of the shoot using a meter scale after different day's interval and the average height of plants were used for statistical analysis. Root length was measured from the base to root end by measuring tape and the average length of root was used for statistical analysis. Numbers of leaves were recorded by counting leaves after different day's interval and the average number of leaves were used for statistical analysis. Number of flushes were counted from base to top of stem on different day's interval and average number of flushes were used for statistical analysis. Collected data were subjected to Analysis of Variance (ANOVA) using standard procedure. Fisher's LSD test at 5% probability level was used to separate the means. Data analysis carried out using R statistical software.

Results and discussions

Plant Height

Plant height of mango nursery plants were recorded increasing trend in terms of days regardless of the years. The maximum plant height was recorded 45.5cm after 60 days of transplanting into polybags similarly 54.12cm was also recorded maximum in 90 and 67.21cm was recorded after 120 days after transplanting into polybags when 15g NPK (20:20:20) was applied into polybags followed by irrigation. The nitrogen, phosphorous and potassium was found very responsive in terms of plant height to stimulate various enzymatic activities. Helmey *et al.*, (2021) recorded the maximum plant height was 65.33 cm in polybags and 61.45 cm in soil with combined mixture of nitrogen, phosphorus and potassium fertilizers. Nitrogen (N), phosphorus (P), and potassium (K) are the three essential nutrients that plants require for healthy development. Nitrogen is essential for chlorophyll production and, by extension, photosynthesis (Kumar *et al.*, 2013). This latest study shown that nutrient availability (NPK) has a substantial influence on mango plants (Salama *et al.*, 2016). Initially, researchers discovered that plant height development exhibited improved flexibility and responsiveness in 10 g of NPK, indicating that appropriate amounts of phosphorus and potassium content in soil media could make plant stems strong and leaves lush (Kacha *et al.*, 2021). Phosphorus is involved in energy metabolism and photosynthesis during mango plant growth, and potassium is involved in carbohydrate and protein metabolism (Bains and Pant, 2003), implying that a reasonable proportion of nutrition (NPK) factors directly promote plant absorption and assimilation, influencing plant growth and development (Neware *et al.*, 2017).

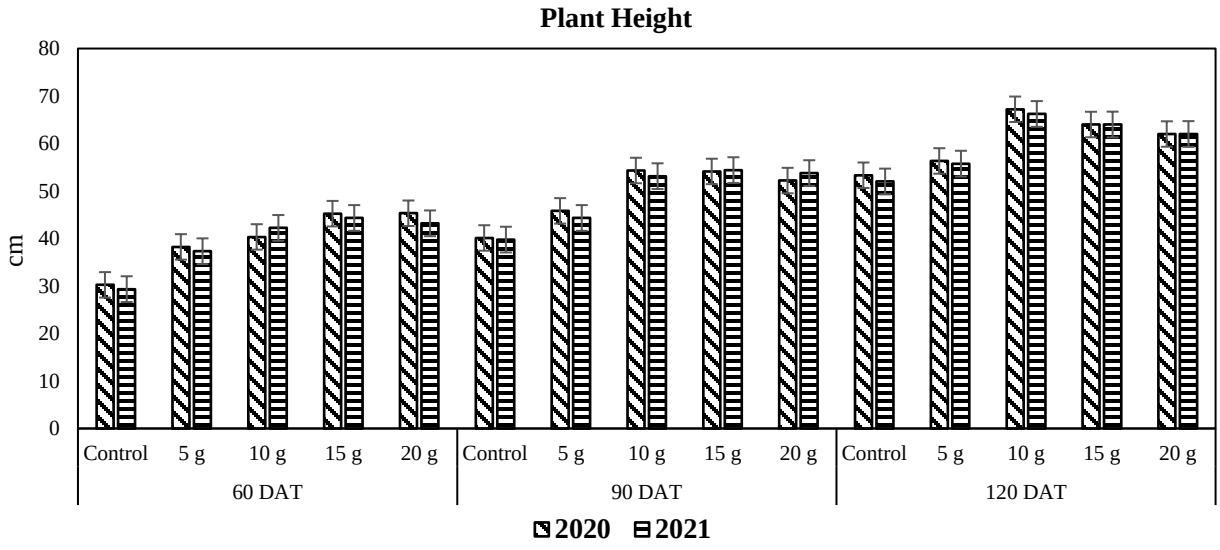

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Figure 1. *Effect of fertilizer doses (NPK) on mango nursery plant height with the effect of days after transplanting during 2020-21.*

Root length

Root length of mango nursery plants were recorded increasing trend and show significantly (P<0.005) maximum in terms of days regardless of the years. The maximum root length was recorded 8.23 cm after 60 days of transplanting into polybags similarly 16.52 cm was also recorded maximum in 90 and 20.71 cm was recorded after 120 days after transplanting into polybags when 15g NPK (20:20:20) was applied into polybags followed by irrigation. The root dry weight biomass and cumulative root length define the size of the root system (Song *et al.*, 2022). A big root system is thought to require more photosynthetic assimilates for production, proliferation, development, and function. The quantity of photosynthetic assimilates involved to create one unit of root dry matter is believed to be twofold that of shoot dry matter (Deivasigamani *et al.*, 2019).

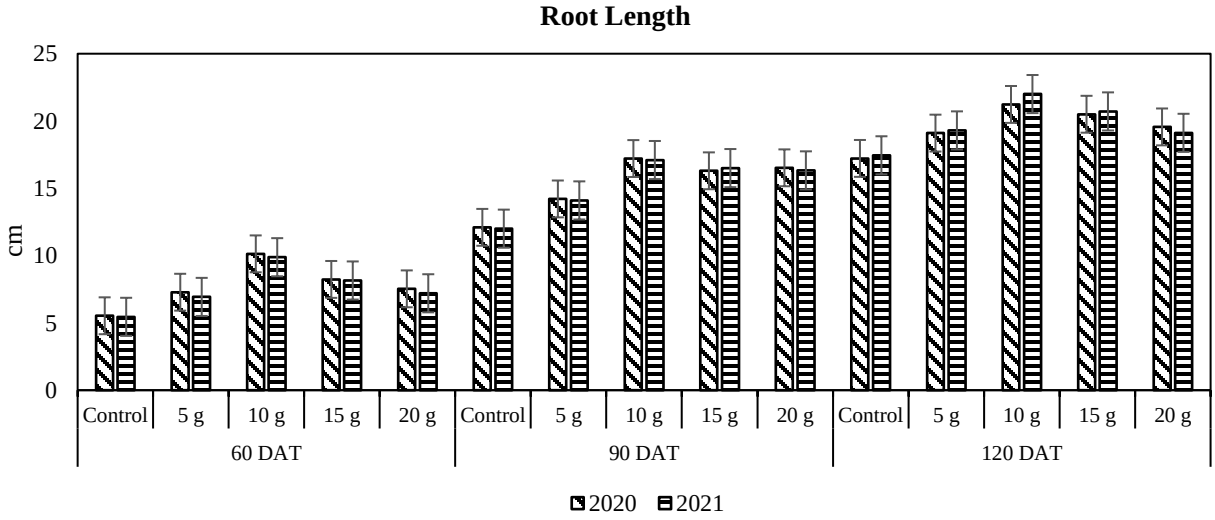

Figure 2. *Effect of fertilizer doses (NPK) on mango nursery root length with the effect of days after transplanting during 2020-21.*

Number of leaf

The number of leaves of mango nursery plants recorded an increasing trend. It showed significantly (P<0.005) maximum in terms of days regardless of the years. The maximum number of leaves was recorded 10.13 after 60 days of transplanting into polybags. Similarly, 17.1 were also recorded maximum in 90 and 31.33 were recorded after 120 days after transplanting into polybags when 15g NPK (20:20:20) was applied into polybags followed by irrigation. The combination of NPK with different ratios as observed with a significant effect on the number of the leaf. The number of leaves increased when the 10 g and 15 g of NPK were applied (Song *et al.*, 2022).

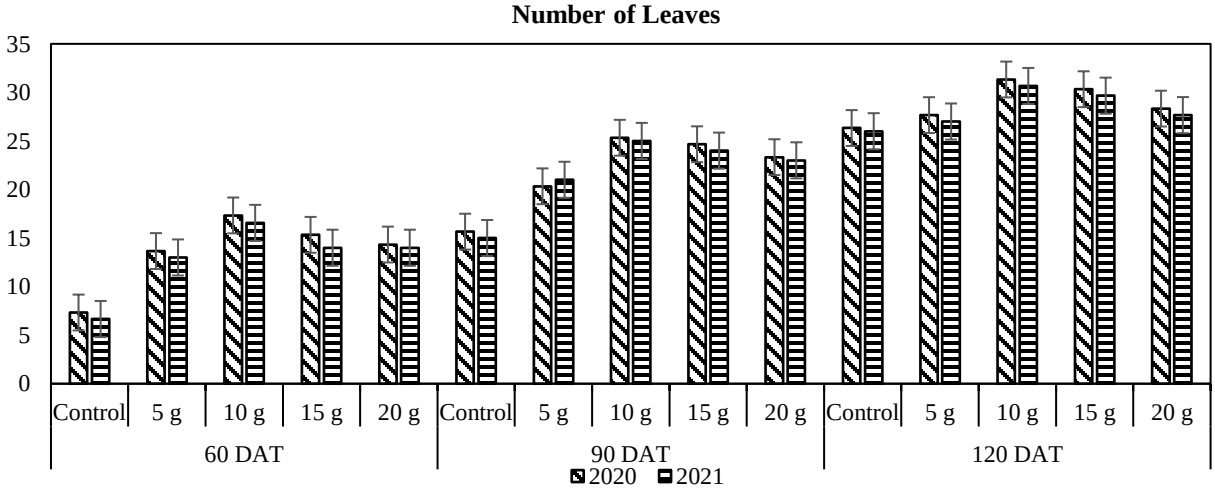

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Figure 3. *Effect of fertilizer doses (NPK) on number of leaves of mango nursery plant with the effect of days after transplanting during 2020-21.*

Number of vegetative flushes

The number of vegetative flushes in mango potted nursery plants were recorded. The increasing trend was observed while increasing the fertilizer dose and showed significant results (P<0.005) regardless of the years. The maximum number of vegetative flushes 4.0 were noted when mango nursery pots were fertilized with 15g, while a minimum 2.0 were noted as compared to control at 30 days interval. Similarly, after 60 days intervals 6 and 7 vegetative flushes were noted during 2020 and 2021 when mango nursery pots were fertilized with 10g. The maximum number of vegetative flushes 8 were noted in years when pots were fertilized with 10g after 90 days intervals (Salomao *et al.*, 2018).

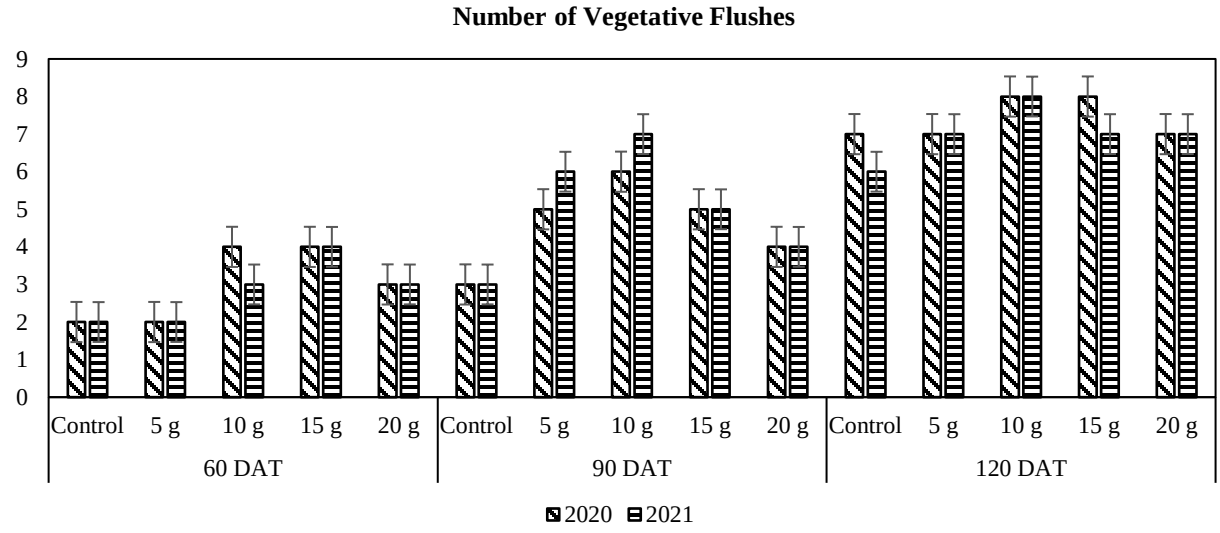

Figure 4. *Effect of fertilizer doses (NPK) on the number of vegetative flushes of mango nursery plant with the effect of days after transplanting during 2020-21.*

Table 1: ANOVA of different NPK fertilizer doses with the effect of different days after emergence and years of mango nursery plants in polybags

SOV	**Plant Height**	**Root length**	**No. of Leaves**	**No. of vegetative flushes**
Fertilizer Doses (D)	0.00034^{***}	0.00054^{***}	0.00382^{**}	0.0077^{**}
DAE	0.00041^{***}	0.00473^{**}	0.0323^{*}	0.0021^{*}
Year (Y)	0.0611^{NS}	0.6011^{NS}	0.445^{NS}	0.5501^{NS}
D x DAE	0.00055^{***}	0.0078^{***}	0.0003^{***}	0.00767^{***}
D x Y	0.233^{NS}	0.662^{NS}	0.44^{NS}	0.542^{NS}
D x Y x DAE	0.00635^{**}	0.0033^{**}	0.00511^{**}	0.00821^{**}

*"*******" highly significant, "^{NS}" Non-significant*

	Plant Height	**Root length**	**No. of Leaves**	**No. of vegetative flushes**
Plant Height	1			
Root length	-0.75*	1		
No. of Leaves	0.88*	0.44	1	
No. of vegetative flushes	0.55	-0.77*	0.83*	1

Table 2. The correlation coefficient of various variables

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Conclusion

Mango nursery plants were found to be optimum, when nutrition to the plant (10g/pot) was applied, followed by irrigation. Maximum plant height, number of leaves and vegetative flushes were recorded at this nutrition regime to keep plant health in good condition. This application will be recommended to use as an optimum dose of nutrition for the potted mango nursery tunnels established as part of the guideline by Mango Research Station, Shuajabad.

Future Prospects

The foliar and pot application of nutrition still needs to be explored. The irrigation quantity and frequency will be optimized and moisture regime in the pot media will also be explored as part of the work.

Conflict of interest

The authors declare no conflict of interest.

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