**Original Research Article**

**Foliar Application of Moringa Leaf Extract and Potassium effect Growth, Yield and nutrient uptake in Blackgram**

**Abstract:**

The present research aims to investigate the influence of the foliar application of Moringa leaves extract (MLE) at 2 rates of 4 % and 8% separately or in combination with potassium on blackgram, a field experiment was conducted at Krishi Vigyan Kendra, Palem, during Rabi season of 2023-24, in sandy soils The experimental design was executed in a Randomized Complete Block Design with ten treatments and three replications. The current study comprised of blackgram cultivar i.e., MBG 1070, foliar spray of bio-stimulant Moringa Leaf Extract (MLE) alone and combined with potassium nitrate and muriate of potash (100% RDF common to all the treatments except control) keeping tap water spray as a control. The investigation includes the assessment of MLE and potassium effect on vegetative growth, yield components and productivity. Application of moringa leaf extract significantly increased the growth and yield attributes as well as grain and straw yield of blackgram. Among various treatments with moringa leaf extract the performance of T9 (100% RDF + 20kg MOP as basal + 8% concentration of MLE sprayed at 30 and 45 DAS) was the best as it produced the tallest plant, Maximum no. of branches, highest of pods per plant and yield.

Keywords: Blackrgram, Moringa Leaf Extract, Growth, Yield and nutrient uptake

**Introduction**

Blackgram is also known as Urd dal in India. It is highly prized in vegetarian diets in India. It is one of the most important pulse crops grown throughout India. It is a short duration leguminous crop and is self-pollinated. The green pods are also edible. Dried blackgram contains about 23.4% protein, 57.3% carbohydrates, 3.8% fibre and 1.0% fat along with 57.3 calcium. Inspite of being widely adapted crop in India, its productivity is very low.

The origin of Moringa tree is the Hamalanian Mountains in the Indian Continent (Osman and Abuhassan, 2015). The leaves and the fruits of the tree are rich in its nutritive values for human and animals. It contains many medicinal and chemical substances for other uses to be called the miracle tree (Osman and Abuhassan, 2015). Among the different usages of Moringa is the leaf extract that contains growth hormones (Price, 2007; Amirigbal *et al.,* 2014).

Many researchers have indicated that moringa is a highly valued plant with multipurpose effects (Rana *et al.,* 2019). The leaves of moringa contain significant amount of phytohormones namely zeatin (cytokinin) and gibberellic acid in addition to other growth-enhancing compounds such as ascorbates, phenolics, and minerals. Due to the cumulative effects of hormones, proteins, minerals, vitamins, essential amino acids, glucosinolates, isothiocyanates and phenolics in Moringa leaf Extract (MLE), it has become a novel, natural bio-stimulant whose application to crop can enrich nutritional status, improve plant antioxidant system and boost the growth and yield of crop. Now-a-days, a number of research works have been conducted by many scientists to unravel the role of MLE on the growth and yield enhancement of vegetable and pulse crops under normal as well as stress situations (Abohassan, and Abusuwar, 2018, Hala *et al.,* 2017, Aluko *et al.,* 2017).

Potassium has been described because the “quality element” for crop production. Potassium increases the protein content of plants, the starch content in grains and tubers, Vitamin-C and therefore the solid soluble contents in fruits. The crucial importance of K in quality formation confirms its role in promoting the assembly of photosynthetic and their transport to storage organs like fruits, grains, and tubers and improve their conversion into starch, protein, vitamins, and oil. Potassium (K), as a plant nutrient features a good crop response and is being reported from many parts of the country. By potassium application pulses showed yield benefits. Improved potassium supply also enhances biological organic process and protein content of pulse grains (Srinivasa rao *et al.,* 2003).

The availability of potassium to leguminous crops is major role at the flowering and pod setting stages (Zahran *et al.,* 1998). K also plays an important role as macronutrient in plant growth and sustainable crop production. It maintains turgor pressure of cell which is important for cell expansion. It helps in osmoregulation of plant cell, assists in opening and shutting of stomata. It plays a key role in activation of quite 60 enzymes (Tisdale *et al.,* 1990; Bukhsh *et al.,* 2011).

**2. MATERIALS AND METHODS**

 **2.1 Experimental Site**

The field experiment was carried out at Krishi Vigyan Kendra, Palem during Rabi, 2023-24. The field is geographically located at 16o51’N Latitude, 78o25’E Longitude. Throughout the crop growth period, a total rainfall of 2 mm was received in 0 rainy days. The experimental soil was sandy loam with a neutral pH (7.02), EC (0.18dS m-1), low in organic carbon (0.58 g kg-1) and available N (141.6 kg ha-1), medium in available P2O5 (32 kg ha-1) and medium in available K2O (228 kg ha-1).

 **2.2 Moringa Leaf Extracts Preparation and Analysis**

Young leaves of moringa were harvested from a fully grown trees located at different places of the KVK, Palem. For preparation of MLE, young leaves of about 100g were taken into a mortar with a pinch of water (10ml/100g fresh material) and ground with a pestle. The juice was extracted by hand pressure and was filtered through the cheese cloth or cotton cloth. The solution was refiltered using Whatman No.2 filter paper. Following the method developed by Fuglie 2000, the extract was diluted with distilled water at ratio of 1:5 and 2:5 and then sprayed directly onto the blackgram plants.

Moringa leaves were shade dried for 1 week followed by oven dry for 4-5 hours at 60oC and then this oven dried sample is grinded into fine powder. Fine powder is for analyses of major and micronutrients and other primary and secondary metabolites, vitamins, enzymes, amnio acids etc., are determined by using fresh leaf sample.

**Table 1. Chemical composition of moringa leaf extract**

 **Name of nutrient element/enzymes Values**

 Total soluble protein (mg g−1) 1.40

 Super oxide dismutase (SOD) 191.86

Peroxidase (POD) 21.99

 Catalase (CAT) 7.09

Total phenolic contents (mg g-1) 8.19

Ascorbic acid (m mole g-1) 0.36

 Gibberellins (mg g-1) 0.74

Zeatin (mg g-1) 0.96

 Nitrogen (%) 1.933

Phosphorus (%) 0.180

Potassium (%) 2.187

Calcium (%) 2.433

Magnesium (%) 0.012

 Zinc (mg kg-1) 38.333

Copper (mg kg-1) 3.50

 Iron (mg kg-1) 544.0

Manganese (mg kg-1) 49.667

 Boron (mg kg-1 ) 21.333

 **2.3 Experimental Details**

The experiment was laid out in a Randomized Block Design (RBD) during Rabi 2023-24, consisting of ten treatments with replicated thrice having net plot size of 4 x 6 m2. The blackgram variety MGB 1070 was sown on sandy loam soil with a spacing of 30 cm×10 cm on 24th October 2023. Nitrogen was applied in the form of urea as per the treatments; Phosphorus was applied as basal dose in the form of SSP. Potassium (50 kg ha-1 ) was applied in the form of muriate of potash (MOP) along with nitrogen and also as foliar spray in the form of KNO3 at 45 DAS (flowering stage), moringa leaf extract was applied at 30DAS (vegetative stage) and 45 DAS (flowering stage) as per treatments, all recommended agronomic practices and plant protection measures were taken as per requirement. The recommended dose of fertilizers: 20 kg N, 50 kg P2O5 and 0 kg K2O per hectare.

 The current study comprised of 100% RDF, muriate of potash 20kg (as basal), potassium nitrate @ 0.5% (foliar spray), alone and combined with foliar spray of Moringa Leaf Extract (MLE), keeping tap water spray as a control, Bio stimulant was foliar applied twice was assessed at 30 and 45 DAS. The parameters were compared between treatments with moringa leaf extract application (at 30 and 45 DAS) and those without moringa leaf extract, under potassium source and 100% RDF.

**Treatment details of the experiment**

T1: Control

T2: 100%RDF (20:50:0, kg ha-1 N: P2O5: K2O)

T3: 100% RDF+ 20 kg MOP as basal

T4: 100% RDF + 0.5% Potassium Nitrate as foliar spray at 45 DAS

T5 :100%RDF + 4% MLE at 30 and 45 DAS

T6: 100% RDF+ 20 kg MOP as basal+ 4% MLE at 30 and 45 DAS

T7: 100% RDF + 0.5% Potassium Nitrate as foliar spray at 45 DAS+ 4% MLE at 30 and 45 DAS

T8: 100%RDF + 8% MLE at 30 and 45 DAS

T9: 100% RDF+ 20 kg MOP as basal+ 8% MLE at 30 and 45 DAS

 T10: 100% RDF + 0.5% Potassium Nitrate as foliar spray at 45 DAS+ 8% MLE at 30 and 45 DAS

**Growth parameters**

The growth parameters consist of plant height, number of branches, number of active nodules and SPAD meter

 **Plant height (cm)**

 Plant height was measured from five randomly selected plants in each plot of an experimental unit. Plant height (cm) was measured from the ground surface to the top most growing point in cm at harvest from all the plots by using a linear meter scale.

**No. of branches/plant**

Five plants were randomly selected within the net plot and the number of branches for a plant was counted at harvest. These individual counts were then averaged and expressed as the number of branches per plant.

 **No. of active Nodules/plant**

Five plants were randomly selected were uprooted carefully from each experimental unit and their nodules were counted. These individual counts were then averaged and expressed as the number of active nodules per plant.

# **SPAD meter value**

 From each plot five plants were selected and SPAD readings are taken by using SPAD meter. These individual counts were then averaged and expressed as SPAD reading per plant.

**Yield and yield attributes**

**No. of pods** **plant-1**

Five plants were randomly selected from each plot after harvesting and their pods were counted. These individual counts were then averaged and expressed as the number of pods per plant.

 **Seeds pod-1**

The number of seeds per pod was measured from the five pods within the net plot was counted. These individual counts were then averaged and expressed as the number of seeds per pod.

**Test weight (g)**

Test weight is the average weight of 1000 seeds obtained after processing, and expressed in grams as test weight.

**Seed Yield (kg ha-1)**

Seed obtained from each treatment in a net plot was weighed using an electronic balance. The seed yield from net plots in each treatment was weighed in g plot-1 and yield was converted to kg ha-1.

**Stover yield (kg ha-1)**

The stover in remaining plant left after seed removal in the same plots. Their weight was recorded and expressed in kg ha-1.

**3. RESULTS AND DISCUSSION**

Exogenous applied MLE and potassium significantly affected blackgram growth, yield and uptake.

**A) Growth parameters**

The data on growth parameters of blackgram are presented in Table 2. Various palnt growth parameter of blackgram crop were affected by varying sources of nutrients.

**1.Plant Height**

A perusal of data in Table (2) clearly indicates that the maximum plant height (30.21 cm) at harvest was recorded under 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS which was at par with treatment 100% RDF + 0.5% KNO3spray at 45 DAS + 8 % MLE at 30 and 45 DAS (27.55 cm). Highest plant height was found with 8% concentration of moringa leaf extract in combination with potassium followed by 4% concentration of MLE. The low plant height (17.04 cm) in control treatment could be the result of less nutrient availability. As reported Potassium plays vital role in meristematic growth through synthesis of Phyto hormone like Cytokine, which helps in plant growth yield attributes by Brar *et al.,* (2004). Moyo *et al*. (2011) might have contributed to the acceleration in growth through rapid cell division, cell multiplication and enlargement

**2. Number of branches per plant**

It is obvious from the data in Table (2) that the result regarding the branches, at harvest the statistically significant the higher number of branches/plant (5.45) was recorded with treatment100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS was found to be statistically on par with treatment 100% RDF + 0.5% KNO3spray at 45 DAS + 8 % MLE at 30 and 45 DAS (4.33). Adding of MLE singly, at various levels, or associated with potassium significantly elevated the branches number compared with nil treatment. Applying MLE together with potassium by far could augment these two characters i.e., plant height and branches number in comparison with nil treatment and/or applying potassium or MLE alone. The highest values were assigned for applying 8%MLE at 30 and 45 DAS+20 kg MOP as basal. The result of this experiment which grew vigorously by application of Potassium was more relevant to Teggelli *et al.,* (2016). These results are in agreement with those finding reported by Foidl *et al*. (2001)

**3. SPAD Value**

Chlorophyll content Data in Table 2 exhibit chlorophyll content (Spad) in blackgram leaves as affected by spraying MLE. Maximum SPAD value was recorded with (T9):100% RDF + 20 kg MOP as basal + 8% MLE at 30 and 45DAS (56.55), which was on par with (T10):100% RDF + 0.5% KNO3 spray at 45 DAS + 8% MLE at 30 and 45 DAS (54.89) and (T8):100% RDF + 8% MLE at 30 and 45 DAS (54.47). The lowest SPAD value was recorded in (T1) control. This treatment either applied singly or in association with potassium significantly heightened chlorophyll content in comparison with control and/or 100% RDF. The result of Yasmeen *et al*. (2014) and Waqas *et al.* (2017) showed that foliar application of MLE increased chlorophyll content in tomato and maize.

**4. Number of Active Nodules:**

Data in Table (2) revealed that the at harvest the significantly higher number of nodules per plant (15.89) was recorded with treatment 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS. The lowest was recorded in control (9.15).

**Table 2. Growth parameters of blackgram influenced by moringa (*Moringa oleifera*) leaf extract and potassium**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | **No. of active nodules** | **No. of branches/plant** | **SPAD Meter value** |
| T1: Control | 17.04 | 9.15 | 2.80 | 48.11 |
| T2: 100% RDF | 21.25 | 12.18 | 3.47 | 50.94 |
| T3: 100% RDF + 20 kg MOP as basal | 21.50 | 13.36 | 3.70 | 51.31 |
| T4: 100% RDF + 0.5% KNO3 spray at 45 DAS | 21.49 | 13.15 | 3.60 | 51.27 |
| T5: T2 + 4% MLE at 30 and 45 DAS | 24.42 | 13.41 | 3.53 | 52.13 |
| T6: T3 + 4% MLE at 30 and 45 DAS | 24.44 | 13.54 | 3.73 | 52.20 |
| T7: T4 + 4% MLE at 30 and 45 DAS | 24.46 | 13.80 | 3.80 | 52.80 |
| T8: T2 + 8% MLE at 30 and 45 DAS | 27.47 | 14.44 | 4.07 | 54.47 |
| T9: T3+ 8% MLE at 30 and 45 DAS | 30.21 | 15.89 | 5.45 | 56.55 |
| T10: T4+ 8% MLE at 30 and 45 DAS | 27.55 | 14.45 | 4.33 | 54.89 |
| SEM+ | 0.92 | 0.47 | 0.38 | 1.13 |
| CD (P=0.05) | 2.72 | 1.40 | 1.14 | 3.36 |

 **B. Yield attributes and yield**

**1. Number of pods per plant**

Data in Table (3) observed the result regarding yield attributes of treatments 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS resulted in significantly higher number of pods/plant. However, no other treatments were found to be at per with 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS. Hussain et al., 2011 reported that potassium significantly influenced the number of pods per plant and other yield attributes.

**2.Number of seeds per pod**

The data pertaining to seeds/per observed in table.3. Significant effect was observed by the statistically analysis of number of seeds/pod. The treatment 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS recorded significantly higher number of seeds/pod (6.03). However, treatment T9 recorded statistically at par with almost all other treatments except control.

**3.Test weight**

Data in Table (3) showed that the statistical analysis on test weight was found to be non-significant. However, highest test weight (42.24 g) was recorded with treatment 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS and the lowest (28.96 g) was observed with control. Test weight was not influenced by the application of any nutrient sources, which might be due to characters highly influenced by genetic makeup (Abraham *et al.,* 2021).

**4. Seed yield**

It is apparent from the data in Table (3) the seed yield showed increasing trend with application of MLE and potassium in blackgram. It rose from 752 kg/ha under control to1757 kg/ha with the application of 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS. Significant and highest grain yield was observed under 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS. However no other treatment was found to be statistically at par with T9 treatment. The effect of potassium increased carbohydrates synthesis and translocation od photosynthesis leads to attributes the better yield reported by Chaudari *et al.,* 2018. Similar results reported by Irshad *et al.* (2022).

**5. Stover yield**

Results in Table (3) revealed that the straw yield of blackgram was also influenced by the application od moringa leaf extract and potassium, it varied from 1434 kg/ha under control to 2738 kgha-1 with application of 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS. Highest stover yield was recorded with 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS, however no other treatment was found to be on par with T9 treatment.

**Uptake of nutrients**

It is evident from the data in Table (4&5) that the average uptake of nutrients by blackgram grain ranged from 8.62 kgha-1 to 23.19 kgha-1 for nitrogen, 1.90 to 4.80 kgha-1 for phosphorus, 8.12 to 24.89 kgha-1 for potassium, 138.68 to 288.51(g ha-1) for iron,81.89 to 169 (g ha-1) for manganese, to for copper and 42.39 to 107.85(g ha-1) for zinc. The ranges of uptake of nutrients by stover were 41.68 to 91.62 kgha-1 for nitrogen, 4.40 to 9.03 kgha-1 for phosphorus, 15.30 to 35.32 kgha-1 for potassium 57.02 to143.74 (g ha-1) for iron, 29.86 to 73.01(g ha-1) for manganese, 12.51 to 25.62 (g ha-1) for copper and 15.55 to 51.23 (g ha-1) for zinc. These results showed that the treatment T9 maintained higher uptake values of all the nutrients most probably owing to the higher yield and T1 recorded the lowest uptake values, which is again the reflection of the lowest yield recorded under this treatment. Application of moringa leaf extract and potassium alone, and combined form along with 100% RDF improved their uptake by blackgram. Similar results reported by Ismail and Ganzour. 2021.

**Table 3. Yield attributes, Seed yield (kg ha-1) and Stover yield (kg ha-1) of blackgram influenced by moringa (*Moringa oleifera*) leaf extract and potassium**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments**  | **No. of Pods plant-1** | **Seeds pod-1** | **Test weight (g)** | **Seed yield****(kg ha-1)** | **Stover yield****(kg ha-1)** |
| T1: Control | 11.13 | 2.67 | 28.96 | 752 | 1434 |
| T2: 100% RDF | 14.77 | 4.53 | 34.92 | 1347 | 2345 |
| T3: 100% RDF + 20 kg MOP as basal | 17.07 | 5.53 | 38.27 | 1454 | 2410 |
| T4: 100% RDF + 0.5% KNO3 foliar spray at 45 DAS | 17.47 | 5.37 | 38.93 | 1395 | 2365 |
| T5: T2 + 4% MLE at 30 and 45 DAS | 19.67 | 5.13 | 39.48 | 1362 | 2361 |
| T6: T3 + 4% MLE at 30 and 45 DAS | 19.73 | 5.77 | 39.74 | 1496 | 2414 |
| T7: T4 + 4% MLE at 30 and 45 DAS | 19.80 | 5.37 | 39.89 | 1397 | 2380 |
| T8: T2 + 8% MLE at 30 and 45 DAS | 22.15 | 5.77 | 41.07 | 1461 | 2441 |
| T9: T3+ 8% MLE at 30 and 45 DAS | 25.23 | 6.03 | 42.24 | 1757 | 2738 |
| T10: T4 + 8% MLE at 30 and 45 DAS | 23.07 | 5.80 | 41.07 | 1527 | 2510 |
| SEm + | 0.72 | 0.41 | 0.90 | 67.48 | 70.64 |
| CD (P=0.05) | 2.13 | 1.22 | 3.36 | 200.49 | 209.89 |

**Table 4. Effect of moringa leaf extract and potassium on uptake of NPK (kgha-1) by blackgram**

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments**  | Nitrogen | Phosphorus | Potassium |
| Grain | Stover | Grain | Stover | Grain | Stover |
| T1: Control | 8.62 | 41.68 | 1.90 | 4.40 | 8.12 | 15.30 |
| T2: 100% RDF | 17.83 | 75.74 | 3.59 | 7.50 | 16.25 | 26.03 |
| T3: 100% RDF + 20 kg MOP as basal | 19.93 | 81.19 | 4.51 | 8.55 | 18.81 | 29.89 |
| T4: 100% RDF + 0.5% KNO3 foliar spray at 45 DAS | 18.46 | 79.96 | 4.37 | 8.33 | 18.64 | 28.79 |
| T5: T2 + 4% MLE at 30 and 45 DAS | 18.21 | 77.45 | 3.31 | 7.32 | 17.75 | 27.23 |
| T6: T3 + 4% MLE at 30 and 45 DAS | 19.63 | 80.13 | 4.08 | 8.53 | 21.05 | 30.25 |
| T7: T4 + 4% MLE at 30 and 45 DAS | 18.17 | 79.69 | 4.24 | 7.80 | 18.72 | 29.32 |
| T8: T2 + 8% MLE at 30 and 45 DAS | 19.43 | 82.60 | 4.14 | 8.64 | 19.96 | 30.25 |
| T9: T3+ 8% MLE at 30 and 45 DAS | 23.19 | 91.62 | 4.80 | 9.03 | 24.89 | 35.32 |
| T10: T4 + 8% MLE at 30 and 45 DAS | 20.61 | 84.25 | 4.33 | 8.62 | 21.07 | 31.21 |
| SEm + | 1.64 | 2.93 | 0.40 | 0.56 | 0.92 | 1.27 |
| CD (P=0.05) | 4.87 | 8.72 | 1.20 | 1.67 | 2.74 | 3.78 |

**Table 5. Effect of moringa leaf extract and potassium on uptake of Fe, Cu, Mn and Zn (g ha-1) by blackgram**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | Iron | Manganese | Copper | Zinc |
| Grain | Stover | Grain | Stover | Grain | Stover | Grain | Stover |
| T1 | 138.68 | 57.20 | 81.89 | 29.86 | 12.51 | 3.99 | 42.39 | 15.55 |
| T2 | 240.07 | 108.53 | 144.38 | 57.86 | 22.29 | 9.47 | 85.62 | 32.20 |
| T3 | 256.25 | 124.13 | 168.01 | 56.44 | 24.63 | 10.06 | 83.16 | 39.15 |
| T4 | 230.86 | 109.25 | 164.41 | 52.70 | 22.21 | 9.43 | 84.19 | 33.45 |
| T5 | 241.79 | 114.76 | 142.74 | 57.08 | 22.88 | 9.18 | 89.33 | 37.06 |
| T6 | 240.91 | 130.07 | 157.58 | 63.43 | 21.84 | 11.10 | 93.29 | 42.93 |
| T7 | 250.72 | 113.58 | 141.97 | 72.07 | 24.10 | 8.94 | 94.41 | 41.65 |
| T8 | 241.78 | 115.01 | 165.62 | 61.01 | 22.82 | 10.57 | 100.15 | 43.94 |
| T9 | 288.51 | 143.74 | 169.00 | 73.01 | 25.62 | 12.05 | 107.85 | 51.23 |
| T10 | 258.46 | 132.16 | 166.89 | 70.77 | 25.21 | 10.35 | 103.00 | 39.72 |
| SEm + | 20.17 | 11.65 | 15.34 | 6.27 | 2.09 | 0.93 | 8.41 | 5.91 |
| CD(P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS |

**Conclusion**

 It can be concluded that the application of 100% RDF+ 20kg of MOP a basal + 8 % MLE at 30 and 45 DAS has recorded significantly higher growth and yield parameters and also higher gross and returns which may be preferable for farmers since it is economically more profitable Significant increase in different growth and yield attributes like plant height, nodules per plant, branches and pods per plant was found by combined application of K and MLE. Moringa leaves may satisfy the nutritional request of plants with lower costs due to their enrichment of nutrients and minerals.

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